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How to improve children's success with arithmetical word problems through the use of a range of scaffolding strategies targeted at the language domain

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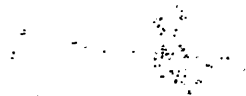
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Chapter 1.

Introduction.



1. Introduction.

Arithmetical Word Problems.

Written arithmetical word problems provide a fascinating link and spiral of dependency between the mathematical and language domains. The correct solution to these problems relies upon an ability to interpret the text correctly, coupled with the ability to find the correct arithmetical equation and sufficient computational skills to solve it (Hegarty et al 1995, Reusser and Stebler 1997 and d'Ailly 1997). The written arithmetical word problems that are being discussed are those that present a problem in word form and require the solver to extract information from the text to form an arithmetical equation and thus find the answer to the question. These problems frequently require knowledge of multiplication and division for their solution, but all the children in the studies discussed in this thesis were given addition and subtraction sums of the combine, compare and change type because the younger children were unsure of multiplication and division processes. This eliminated any possibility of different processes affecting the outcome of the research which may have occurred if older children had been given multiplication and division and the younger ones had been given addition and subtraction problems. Although the semantic structure of the text can affect the type and degree of difficulty of the problems - and this will be discussed in detail in Chapter Two of the thesis - the following are examples of the underlying structures of arithmetical word problems used in this research:

Compare:

Greg and Tara were collecting shells on the beach. Tara had 18 shells.

Greg had 9 shells more than Tara. How many shells did Greg have?

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Combine:

Andrew has 17 shells and Greg has 27 shells. How many shells do they have altogether?

Change:

Tara had 18 shells. Greg gave her 27 more shells. How many shells does Tara have now?

There is considerable evidence that children find these written arithmetical word problems difficult (e.g. Stern 1993, Hegarty et al 1995, d'Ailley 1997, Greer 1997, Gravemeijer 1997, Reusser and Stebler 1997, Yoshida et al 1997, Wyndham and Saljo 1997) because their complexity demands that the solver uses knowledge and skills from both mathematical and language domains, and many children either fail to appreciate this or do not use their knowledge judiciously. A child who is good at computational arithmetic may fail to formulate the correct arithmetical equation because of a lack of understanding of the text and will not reach a correct solution. A child who understands the meaning of the text of these problems but fails to recognize the appropriate arithmetical equations will not be able to answer them accurately. A child who understands the text and has knowledge of the required arithmetical process and uses the correct arithmetical equation, but is inaccurate in arithmetic, will also produce a wrong answer. For many children, arithmetical word problems are fraught with difficulties that result in failure. Children can easily misconstrue this lack of success as their deficiency in mathematics; therefore, it is imperative that the source of the children's difficulties should be identified and that solutions should be sought.

The interdependency of the language and mathematical domains in these problems accentuates both the differences and similarities between the domains in aspects of learning and teaching styles. It also emphasizes the resistance of most pupils to transferring

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learning from one domain to another. Although they unite domains, in schools written arithmetical word problems are traditionally situated in the mathematical domain where their mastery is seen as a test of mathematical ability, demonstrating that the pupil can apply mechanical processes to real world situations (Hegarty et al 1995, Greer 1997, Gravemeijer 1997, Yoshida et al 1997, Wyndham and Saljo 1997). Written arithmetical word problems are considered to indicate that the learner has sufficient understanding of arithmetical processes to move beyond the rote learning of arithmetical number facts and apply these facts to solving problems.

‘Problem solving is seen as a decisive test of genuine skill and understanding.’ (Wyndham and Saljo 1997)

Arithmetical word problems are still a fixture within the school curriculum although some express doubt about the relevance of the type of problems usually given in schools (Gerofsky 1996). It may be easier to persuade adults to change and adapt the text and focus of word problems than to remove them from the curriculum. These problems are potentially important to the curriculum because they hold the possibility of encouraging cross domain learning, an accurate interpretation of written texts and making mathematics learning relevant to life outside the school environment.

My initial concern was to find a solution to children’s difficulties with these problems within the mathematical domain because the problems are presented to children within this domain in school. I decided to explore the possibility of scaffolding children in the mathematical domain as an attempt to address this issue. However, the Initial Study indicated that it was necessary to approach the issue by helping children to interpret text within the language domain by using scaffolding techniques, and then transfer that ability to interpret text to the mathematical domain and this is the main focus of this thesis.

Chapter 2.

Arithmetical Word Problems.

2. Arithmetical Word Problems.

Arithmetical word problems are complex in their structure and the problem solver needs to understand when and how to apply certain language and arithmetical strategies to reach a correct solution. These problems have been a part of school culture for years and it is well documented that many find such problems difficult to solve (Stern 1993, Hegarty et al 1995, d'Ailley 1997, Greer 1997, Gravemeijer 1997, Reusser and Stebler 1997, Yoshida et al 1997, Wyndham and Saljo 1997). However, to consider that children fail because of a lack of either linguistic or mathematical skills, or a combination of both, would be to adopt an approach that is too simplistic because it would disregard the arguments surrounding the problems themselves, the complex structure of the 'genre' of these problems and the various problem-solving techniques employed by the children.

Many believe arithmetical word problems to be a test of mathematical ability because they give the pupils the opportunity to move beyond the rote learning of arithmetical processes and demonstrate their ability to apply mechanical processes to real world situations. (Greer 1997, Gravemeijer 1997, Hegarty et al 1995, Yoshida et al 1997, Wyndham and Saljo 1997). This is a debatable point on several counts including:

- The content of the problems rarely reflects real world situations.
- Adults frequently do not use conventional arithmetical procedures to solve arithmetical problems they encounter in their everyday lives for a variety of reasons. (Walkerdine 1988)
- In schools, they are frequently used as a test that children can use an arithmetical process they have just learned in a written word problem.

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- Many children recognise the problems for what they are and extract the arithmetical content to form the equation while disregarding the text (Kintsch 1998 and Gerofsky 1996).

There is a tendency in schools to mathematize everyday activities by suggesting that children encounter mathematics in their everyday lives and mathematical curricula and textbooks uphold this myth of mathematization by giving children problems that refer to supposedly typical instances in everyday life, described by Dowling (1998) as 'the myth of reference'. Dowling (1998) says that this

'...is endemic in school mathematics. These mathematical tasks, for example, are taken from the 'Y' series of reference books in the secondary school mathematics scheme, SMP 11-16:

Shopkeeper A sells dates for 85p per kilogram. B sells them at 1.2 kg for £1.

- a) Which shop is cheaper?
- b) What is the difference between the prices charged by the two shopkeepers for 15 kg of dates? (SMP 11-16 Book Y1, p55)

Britannia best British flour cost £0.71 for 12.5 kg.

Uncle Sam's best American flour cost \$1.30 for 3.5 lb.

If $1 \text{ kg} = 2.2 \text{ lb}$ and $£1 = \$1.85$, which brand of flour was cheaper, and by how much per kilogram?

(SMP 11-16 Book Y1, P56)' (Dowling 1998).

Both these tasks recruit a domestic shopping setting but, as Dowling (1998) observed, it is quite apparent that the tasks are mathematical rather than domestic from various clues set within the text.

- The letters A and B identifies the shopkeepers.

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- The names of the brands of flour are stylized and the comparison is unrealistic because it is unlikely that anyone would cross the Atlantic for cheaper flour.
- The comparison is incomplete because the question does not consider other factors such as the different standard of living or the availability of flour that influences such purchases.

Schools claim to use domestic settings to recreate 'real-life' situations for the presentation of arithmetical problems but this claim fails first because they rarely emulate the times when mathematics is needed in the home, e.g. measuring a room for a carpet, calculating the number of wallpaper rolls required, altering the ingredients of a recipe to cater for a different number than the cookery book suggests, and second, because when they appear to reflect life, they fail to consider the aspects of life that govern our choices. Walkerdine (1988) discussed one such question that was given to children in a national numeracy test. Two bottles of tomato sauce, of different sizes and prices, were presented and the solver was asked which one was the best buy. As Walkerdine (1988) observed;

'This is assumed to be a practical application of a particular kind of mathematical calculation. But let us consider how, in practice, I might make a choice in a supermarket. Do I have time to make a calculation? Are there non-mathematical reasons for preferring one bottle to another? For example, I may not think the taste or quality of the cheaper sauce is good, or my family may dislike it. It may come from a country whose goods I do not wish to purchase. Or, of course, I may only be able to afford the cheaper brand. This means that whether or not I calculate it is not simply about my 'ability' to do so.' (Walkerdine 1988).

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Gerofsky (1996) argues that most problems introduce characters that are irrelevant, and that they can prove a distraction for some children in translating the words into an arithmetical equation. Such problems hold difficulties within their texts ranging from having a deprived content - which really could not be considered to be fiction - to the confused tenses that appear in many. As Gerofsky (1996) observed, the story content of the problems is so poor that frequently it seems that the writer is suggesting that it be ignored. Nevertheless, children fail because they do not use the important information within the text of the problem to solve the problems.

In the language domain, and this will be discussed in detail in Chapter 6, many of the 'interpretation' exercises given to the children are questions which lead them to the answer in the text and the margins of error are small because the questions are so closely related to the text. A question on the story of e.g. 'Cinderella' may ask:

'When did Cinderella have to leave the ball?'

This approach does not prepare the problem solver for the type of texts encountered in an arithmetical word problem in the mathematical domain where the solver does not have to answer a simple question about the text of the problem, but has to interpret the question and the text, and then construct an arithmetical equation using that information. The question in an arithmetical problem does not direct the solver to focus on salient parts of the text, so not only can the solver not check if their understanding of the text is correct, but they use this understanding - or misunderstanding - to form an arithmetical equation from their estimation of the meaning of the text. The solver is required to use the meaning of the text in the language domain to construct an arithmetical equation in the mathematical domain. This creates several difficulties.

- Many children may not really be in the habit of considering the text in the language domain because they have used words on the question to direct them to the appropriate parts of the text, therefore they have no interpretative skills to be carried over to and utilized within the mathematical domain.

2. **Arithmetical Word Problems:**

- The type of word problems used 'within the culture of mathematical education' (Greer, 1997, Gerofsky 1996) actually encourages the children to refrain from making sense of the meaning of the question because they can be solved by using the key mathematical words and the numbers in the text to form an arithmetical equation.
- As has already been stated, sometimes the text is inadequate and there is an over mathematization of everyday situations. (Walkerdine 1988, Dowling 1998 Gerofsky 1996.)

On the other hand, when children use their imagination or try to consider the text of the problems, different sets of difficulties arise. An inadequate text brings the reader into conflict with the text because there are underlying considerations that are not explicit in the text, but are in the minds of the reader who are immersed in their interpretation of the reality of the text and therefore make mistakes. Greer (1997) observed,

'The analysis of what is meant by "reality" in this context is extremely complex and subtly nuanced. The following example (Freudenthal, 1991, p70) might appear at first sight reasonable to model by addition;

Mr Smith the butcher had 26 kg of meat in his shop, and orders 10 kg more. How much meat does he have now?

Yet Freudenthal comments that "the ham ordered by phone does not fly instantly into the shop, and when it arrives some of the 26 kg of ham ...will have been sold. Indeed this is why the butcher ordered more". (Greer 1997)

Consequently some children may have justifiably wrong answers simply because they are interpreting the text according to their experience of the reality of the situation, or they are engrossed in the

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imaginative possibilities suggested by the text while others are totally ignoring the text. Some children have what Anghileri (1995) describes as 'a selective attention' and they find it difficult to sort out the relevant from the irrelevant even though they appear to be observing everything. As in most areas of school work, teachers' and pupils' perspectives of word problems may be different because the teacher may be concerned with teaching the child how to find a solution, but the child may be distracted by the attempt at making the subject relevant to life outside the school (Pimm 1995).

It seems from such evidence in the research that children tackle the text very much on a personal level and according to their own inclinations. On the other hand, these problems are deeply entrenched in the tradition of school mathematics and are likely to remain there, so it is important that children learn to use the text and that they are given a text which grasps them, enthralls them, or, at the very least, amuses them (Gerofsky 1996). Unfortunately, this is not the experience of most children. For example, Walkerdine (1988) observed a teacher attempting to use a shopping game to introduce children to the use and value of money. The prices were ridiculous, the 'shopkeeper' returned the money to the 'shoppers', and the 'shoppers' returned the goods to the 'shop' to allow the game to continue. It is not possible to teach children to interpret the text of arithmetical word problems realistically when the context of the problems is problematic. Many children, therefore, choose to ignore the text although they recognize the structure of the problems and use this as a basis for the formation of an arithmetical equation and this means that they may not have considered the relationship of all the variables in the question (Walkerdine 1988 and Gerofsky 1996). DeCorte and Verschaffel (1991) observed that the older research studies on the effect of task variables on children's arithmetic word problems concentrated on the surface characteristics of the structure of the number sentence within the problem, the presence of a cue or key mathematical word, the place of the question and even the number of words in the problem. However, in recent years the focus

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of the research into all aspects of arithmetical word problems has shifted towards the semantic structure of the problem. This older research must not be totally discounted as there is evidence that some children attempt to solve even unsolvable problems by using the key mathematical words in the text (Stern 1993, Hegarty et al 1995, Gravemejer 1997, Wyndham and Saljo 1997 and D'Ailly et al 1997). It is necessary to consider the semantic structure theory in conjunction with other research rather than considering it a replacement or development of previous research. This more recent research is based on two assumptions:

- '1. Word problems that are solvable using the same arithmetic operations, can be described in terms of different network concepts and relationships underlying the problem.
2. Constructing an appropriate internal representation of such a conceptual network is a crucial aspect of expertise in word problem solving.' (DeCorte and Verschaffel 1991).

It has already been stated in the Introduction that the arithmetical word problems, which are the concern of this research, fall into three categories. They are defined as 'change', 'combine' and 'compare' problems and are typical of the realistic problems requiring an addition or subtraction arithmetical equation to reach a solution that are given to children in schools (Riley et al 1983).

- **Change problems:** some event changes the value of a quantity, e.g.
'James has 3 apples. Catherine gave him 4 more apples. How many apples does James have now?
- **Combine problems:** static situations involving two amounts which are combined, e.g.,
'James has 3 apples and Catherine has 4 apples. How many do they have altogether?

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- **Compare problems:** two amounts are compared and the difference between them has to be found, e.g.,
'James has 3 apples and Catherine has 4 more than James.
How many apples does Catherine have?

The simple format of these exemplars is very restrictive and teachers change them to give examples that are more varied. Although it is probably an unintentional effect, this can alter the semantic structure of the problems. Hence, DeCorte and Verschaffel (1991) consider that this categorization of problems can be subdivided further depending on the identity of the unknown quantity. In compare and change problems, there are even more subdivisions depending on whether the wording of the problem is asking the solver to add or subtract. DeCorte and Verschaffel (1991) cite Riley et al (1983) who distinguished fourteen types of simple addition and subtraction sums that occur within the change, combine and compare categories. This categorization cannot be considered as definitive because the accessibility of these problems to the solver depends on their semantic structure.

Many of these problems can be solved using the same arithmetical operation; but they differ because their underlying semantic structure determines their degree of difficulty. The simple

'James had 3 apples. Catherine gave him 4 more.

How many does James have now?'

is a change problem where the direction is increase and the unknown is the result set. This can become more difficult when the unknown is the change set:

'James had 3 apples, then Catherine gave him
some more. Now James has 7 apples. How many
did Catherine give him?'

Even though there are only three different schemas within these fourteen different types of problems discussed by DeCorte and Verschaffel (1991) the semantic structure of these problems dictates that various arithmetical process be used to reach a correct solution.

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There are six change problems, two combine and six compare problems all presenting changing levels of difficulty to the solver because of their semantic structure. The following table, very slightly adapted from DeCorte and Verschaffel (1991), explains the differences in the problems.

Table 2.1

Type	Example	Schema	Direction	Unknown
Change 1	Jim has 3 apples; then Ann gave him 5 more apples. How many apples does Jim have now?	change	increase	result set
Change 2	Jim has 8 apples, then he gave 5 apples to Ann. How many apples does Jim have now?	change	decrease	result set
Change 3	Jim had 3 apples, then Ann gave him some more apples. Now Jim has 8 apples. How many apples did Ann give him?	change	increase	change set

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Change 4	Jim had 8 apples; then he gave some apples to Ann. Now Jim has 3 apples. How many did he give to Ann?	change	decrease	change set
Change 5	Jim had some apples then Ann gave him 5 more apples. Now Jim has 8 apples. How many apples did Jim have in the beginning?	change	increase	start set
Change 6	Jim had some apples, then he gave 5 apples to Ann. Now Jim has 3 apples. How many apples did Jim have in the beginning?	change	decrease	start set
Combine 1	Jim has 3 apples. Ann has 5 apples. How many apples do they have altogether?	combine	_____	superset

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Combine 2	Jim and Ann have 8 apples altogether. Jim has 3 apples. How many does Ann have?	combine	_____	subset
Compare 1	Jim has 8 apples. Ann has 5 apples. How many apples does Jim have more than Ann does?	compare	more	difference set
Compare 2	Jim has 8 apples. Ann has 5 apples. How many apples does Ann have less than Jim?	compare	less	difference set
Compare 3	Jim has 3 apples. Ann has 5 more apples than Jim. How many apples does Ann have?	compare	more	compared set
Compare 4	Jim has 8 apples. Ann has 5 apples less than Jim does. How many apples does Ann have?	compare	less	compared set

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Compare 5	Jim has 8 apples. He has 5 more apples than Ann. How many apples does Ann have?	compare	more	reference set
Compare 6	Jim has 3 apples; he has 5 less than Ann. How many apples does Ann have?	compare	less	reference set

For example, adding the two given numbers can solve the combine 1 problem, change 6 problem and compare 3 problem but the semantic structure of their texts gives them different levels of difficulty.

MODELS OF LEARNING.

DeCorte and Verschaffel (1991) found that the type of question affected the percentage of correct solutions to arithmetical word problems. They used the following table from Pauwel (1987) to explain the results:

Table 2.2.

Percentages of correct solutions for the 14 types of word problems in Pauwel's (1987) study (N=126)

<i>Problem type</i>	<i>%</i>
<i>correct</i>	
Change 1	97
Change 2	88
Change 3	73
Change 4	78
Change 5	67
Change 6	83

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<u>Problem Type</u>	<u>%</u>
Combine 1	98
Combine2	62
Compare 1	79
Compare 2	78
Compare 3	47
Compare 4	44
Compare 5	46
Compare 6	38

Although the previous results are from only one study, there is a consensus agreeing with the broad findings of the study. (Stern 1993, Hegarty et al 1995, Gravemejer 1997, Wyndham and Saljo 1997 and D'Ailly et al 1997). The reasons for the variations in results are because:

'....the difficulty level of semantically distinct problems can differ either because the semantic schemes necessary to represent the different problem types are not equally well mastered by children, or because some problem representations are more easily mapped with an appropriate arithmetic operation than others.' (DeCorte and Verschaffel 1991).

This process of mapping occurs when the solver reads the text, extricates the information for the formation of an arithmetical equation and solves the equation. Decorte and Verschaffel (1991) identify five specific stages in a successful mapping process:

1. The pupil uses the text to construct an internal representation of the problem.
2. Based on that representation, the pupil selects a formal arithmetical operation or counting strategy to find the answer.

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3. The pupil carries out the arithmetical operation.
4. The pupil reconsiders the initial problem, replaces the unknown element by the result of the arithmetical operation and formulates the answer.
5. The answer is checked.

The difficulties experienced by many problem solvers occur precisely at this first point of mapping because they fail to interpret the text of the problems for the reasons already discussed.

It has already been said that it is easier to construct an equation for a problem where

‘the temporal sequence of the data presented by the text matches the order of events in real life and also matches the order of the data in an arithmetic sentence,..’ (Teubal and Nescher 1991).

It is easy to translate this type of problem into an arithmetical equation because the text base matches the order in the equation. In problems such as the Compare 6 type, on the other hand, a situational model corresponding to the text base must be constructed and it is from this situational model that the arithmetical equation to solve the problem is formed (Teubal and Nescher 1991). To form the necessary arithmetical equation, the problem solver must construct the situational model correctly by translating the meaning of the text accurately. This transfers the ‘burden of the solution process’ from the solution of an arithmetic sentence to the translation of the text into to an arithmetical sentence (Teubal and Nescher 1991). It is imperative that the solvers translate the text accurately because it is this translation that clarifies the relationships between the numbers in the text and dictates how they are to be used to form the arithmetical equation.

A ‘linguistic restructuring strategy’ (Stern1993) is necessary to rearrange the information because the solver must use the words of the text rather than rely on the mathematical information. Solvers who

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adopt a direct translation, a short-cut approach, to arithmetical word problems, often use the words 'less' and 'more' to construct an arithmetical equation to find the solution to the problem (Hegarty et al 1995). 'More' initiates the use of addition and 'less' prompts subtraction. The problem solvers combine the numbers in the text in some way that seems to them to be appropriate or solvable to produce an answer to the problem. In a problem such as Compare 6, (DeCorte and Verschaffel 1991) 'a two-step word problem containing a relational statement' (Hegarty et al 1995), the word 'less' prompts the use of an inappropriate subtraction equation. This is an 'inconsistent' problem because the key mathematical word 'less' prompts the use of an incorrect arithmetical process; while in a 'consistent' problem the keyword prompts the correct arithmetical process (Hegarty et al 1995).

Sometimes it is possible for problem solvers to produce an accurate solution to the problems by using key mathematical words in the text, especially in consistent problems because the key mathematical word prompts the required arithmetical process. Unfortunately, this approach is just as likely to result in an inaccurate answer to the problems because the problem solvers may use the wrong combination of numbers to form the arithmetical equation. In the problem model approach, also known as a meaningful approach, the situation in the problem is translated into a mental model that is used to construct an arithmetical equation for the solution of the problem. Problem solving strategies are individual, so it is not possible to conclude that one strategy always results in failure and another in success; nevertheless, research indicates that problem solvers who rely on the key mathematical words e.g. 'less' in the text are less successful than those who use the mental model of the text to solve problems. (Hegarty et al, 1995 and Gravemeijer 1997).

Nonetheless, word problems have the potential to be a worthwhile exercise. They entwine the language and mathematical domains in a dual dependency upon each other and they could be used to

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demonstrate how adults really do need to use mathematics in everyday settings, whether it is in a domestic or work situation. (Nunes et al 1993, Askew 1998 and Hughes et al 2000). A more imaginative approach could be adopted. (Gerofsky 1996) Children do not need to have problems related to real life as they respond well to fiction, but the problems do need to belong to the text and be reasonable even though they are imaginative. Reducing these problems to an assessment of an arithmetical process also fails to release their potential. These problems could be written in ways that capture the imagination of the children while coercing them to use both domains. Although the structure and content of word problems which usually are given to children in school has been widely criticised (Walkerdine 1988 and Gerofsky 1996), Carpenter and Fennema (1992) suggest that when teachers are knowledgeable about the processes of children's thinking and problem solving techniques, they are better equipped to offer children problems which are relevant to their understanding and interests and I will go on to demonstrate this in the Thesis.

Chapter 3.

Scaffolding.

3. Scaffolding.

PIAGET, VYGOTSKY AND THE ZONE OF PROXIMAL DEVELOPMENT.

Vygotsky's (1978) work, which articulates the crucial role of society in child development and education, embodies constructivist perspectives and unites the learner-child with the instructor-adult or knowledgeable peer. Vygotsky (1978) considered children to be active participants learning about and within their society and their environment rather than isolated individuals whose learning was dictated by their abilities and developmental levels. Although Piagetian theories have been criticized for being overly prescriptive in defining ages of development, they cannot be totally rejected because they focus attention on the developmental stages of children and provide an insight into children's minds. Piaget did not define these stages as a universal phenomenon although he underestimated factors we consider nowadays as important influences on the outcome of learning. According to Confrey (2000), we are not meant to interpret the Piagetian developmental stages without considering causes such as adult interventions, cultural variations and the effects of various curricula and varied types of instruction.

'Stages for Piaget were broad categories of age during which certain kinds of behaviors could be expected under typical conditions of a population from which one samples.' (Confrey 2000).

Vygotsky believed that the child learned on two levels:

'Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an

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interpsychological category, and then within the child as an intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts, and the development of volition.' (Faulkener et al 1998).

Therefore, the individual aspect of learning must not be discounted because the learner must internalize as an individual that which is learned in society. This theory emphasizes the social nature of learning which, rather than depending on the transmission of knowledge from the teacher, needs the voluntary participation of the learner and the response of the tutor to the learner. Vygotsky used the term 'the zone of proximal development' (ZPD) to describe the situation in which a child can do something with the help of another, but cannot manage to do it alone. He considered this zone to be effective in both organizing instruction and in the assessment of intelligence. The zone of proximal development is frequently applied to the harmonious relationship between learner and tutor in a social dyad, (Woods et al 1976) and there may be some difficulty in transferring this application of the concept to a typical primary school classroom without a redefinition of the zone in terms applicable to classroom learning. However, Vygotsky (1978) himself defined the zone in slightly different ways depending upon the situation and, as Renshaw (1999) observed, it is acceptable to adopt this approach to modern schools:

'The most widely quoted definition describes the ZPD as the distance between what a child can achieve alone, and what a child can achieve with the assistance of a more advanced partner. The more advanced partner, of course, might be a cultural invention such as an interactive computer program that might extend a person's repertoire of skills and know-how by responding adaptively to

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specific moves. This notion of the ZPD has highlighted the way peers and adults can scaffold the participation of young learners in cultural activities, for example, by directing attention to key aspects of the task, simplifying the task, monitoring ongoing performance, and adjusting the degree of assistance depending on the partner's level of engagement. The mediational means - the cultural tools - that a learner appropriates are not like prepackaged objects, waiting to be selected from a supermarket shelf. These tools are embodied/embedded in the social practices of the existing community and it is typically the adults - parents, teachers, carers etc - of that community who initially mediate appropriation of the tools by the children/learners/novices. So, the mediational means themselves are social as is the process of appropriating them.' (Renshaw 1998).

Vygotsky (1978) believed that instruction should be nearer the level of potential development rather than the level of actual development and he considered it to be as important to measure the level of potential development as the level of actual development within the classroom situation. Such analyses must correspond to intramental and intermental functioning to be beneficial as both are of equal importance in knowing the future potential of the child. (Faulkner et al eds. 1998)

There has been some criticism that the zone could compare with a behaviourist approach in that the adult controls the learning, (Renshaw 1998) but the child is a voluntary partner in the process and cannot be forced into cooperation. Conversely, it has been argued that the zone is a site of a contest of powers between child and tutor with the child attempting to control the situation and the

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adult accused of adopting a behaviourist paradigm by refusing to follow the child. As Renshaw (1999) states;

'In summary, this critical debate has been useful in clarifying two issues regarding the ZPD. First, it is a co-constructed interactive space in which both the learner/novice and the teacher/expert are active agents, and second, appropriation in the ZPD necessarily involves contest between partners about how the task should be interpreted and approached, that is, it involves contest about mediational means/cultural tools. If there is no difference between the partners then there is no challenge to existing practices/understandings and, by definition, no possibility of creating a ZPD.' (Renshaw 1998).

Scaffolding in the classroom.

Kintsch (1998) redefined the zone of proximal development as the 'zone of learnability' when he applied it to the classroom situation and said:

'If a student's knowledge overlaps too much with an instructional text, there is simply not enough for the student to learn from that text. If there is no overlap, or almost no overlap, there can be no learning either. The necessary hooks in the student's knowledge, onto which the new information must be hung, are missing.' (Kintsch 1998)

In order to function as effective scaffolders within this zone of learnability, teachers must have knowledge of children's thinking to respond to the children's needs and to be aware of the instant to fade help when the children can perform on their own. The value of this

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knowledge of children's thinking is demonstrated in the Cognitively Guided Instruction approach of Carpenter and Fennema (1992) in which teachers were helped to understand children's thinking. Although the teachers were not given teaching materials, this insight into how children think permitted them to make decisions about their classroom practice. They adapted their methodologies to respond to the level of understanding of their pupils and listened to their pupils. The 'critical element' (Carpenter and Fennema 1992) was the ability of the teachers to assess the capabilities of their pupils as part of the ongoing instruction rather than as separate tests. There was always a considerable amount of discussion about the problems and the teachers and pupils responded to one another. Although this academic knowledge is important, it does not exclude knowledgeable peers from the scaffolding process because children are often aware of the difficulties of others, possibly because they themselves have recently acquired the relevant knowledge and understand the difficulties of those who have not yet done so.

The image of the learner, which was perceived as this study developed, is best summarized in the words of Confrey (2000) when discussing his views of constructivism:

'Although the theory stresses the need for each person to form their own understanding of a concept, it recognizes that this process is embedded in and aided by social and cultural relations. Tasks and problematics are mediated by cultural distinctions and defined through social interactions, both peer-to-peer and teacher-student. Acceptable and likely forms of action on objects are influenced by one's view of those objects as cultural tools. Methods of representation, the language of description, representation are profoundly influenced by the intellectual resources of the environment.

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Communication with others is essential in explanation and justification. Self-regulation is often achieved through the internalization of a scheme as a result of assessment of one's satisfaction of a felt-need, often governed by interactions with others' (Confrey 2000).

SCAFFOLDING WITHIN THE ZPD.

It is at the point of learning where the pupil has sufficient prior knowledge, but lacks full knowledge that scaffolding occurs. Within the zone, the adult takes over the part of the task that the child cannot yet understand but draws back and fades help as the child progresses until the child can manage alone. Bruner (1985) was the first to utilize this term, 'scaffolding', to describe the specific help that is given to the learner within this zone of proximal development. Scaffolding is unique in that it holds the negotiated joint activity constant while simplifying the learner's role, so the learner knows what the task entails. The learner is aware of the expected goal from the beginning and achieves it with as much or as little help as is required. However, scaffolding is more than a simple exercise in giving help when the learner asks for it, or when the adult notices the learner is floundering. The tutor has to be aware of the help that the learner needs either by close observation when the task is being carried out, or through a thorough knowledge of the learner's capabilities. Wood et al (1976) articulated the qualities of a tutor when they said,

'The effective tutor must have at least two theoretical models to which he must attend. One is a theory of the task or problem and how it may be completed. The other is a theory of the performance characteristics of his tutee. Without both of these, he can neither generate feedback nor devise situations

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in which his feedback will be more appropriate for *this* tutee in *this* task at *this* point in task mastery.' (Wood, Bruner and Ross. 1976).

Scaffolding fits within constructivist theories because the role of the teacher is defined as one who listens to the learners with an open mind and listens to students. This responsiveness to the specific and changing needs of the learners permits scaffolding. Confrey (2000) defined the constructivist teacher as one who considered learners

'not as incomplete adults, but as sense-makers with a different field of reference and intellectual resources. Constructivism obligates teachers to ferret out the possibilities and richness of approach in students' proposals.' (Confrey 2000).

There are specific activities and tasks which are used in providing the scaffolding - 'the supporting structures' (Bransford et al 1999) - for the child's learning such as:

1. RECRUITMENT. Enlisting the children's interest in the task.
2. REDUCTION IN DEGREES OF FREEDOM. Simplifying the task by reducing the number of acts to reach a solution and to a level where the learner could recognize if the task had been completed satisfactorily.
3. DIRECTION MAINTENANCE. Keeping the child motivated to achieve the goal.
4. MAKING CRITICAL FEATURES. Interpret discrepancies for the child.
5. FRUSTRATION CONTROL. Helping to remove stress caused by the possibility of not completing the task.

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6. DEMONSTRATION. Completion or providing an explanation of how the task is to be completed. (Wood et al 1976, Bransford et al 1999).

Although these practices are characteristics of scaffolding, the child may not have to experience each activity to the same degree for every task. The learner and the adult must share the end goal of the negotiated joint activity but the level of motivation, tutor help or demonstration will depend upon the learner's response to the task and to the tutor, and on the tutor's response to the learner. Nevertheless, the tutor should have an awareness of the child's needs and abilities and be extremely sensitive to the help required to complete the goal. It is more difficult, if not impossible, for a teacher in a classroom situation to be susceptible to every minute change in the learner which indicates that a change in the level of help from the tutor is required, or that the learner is now capable of performing the task alone. Therefore, although scaffolding seems to be the ideal way to teach if children are to reach their maximum level of competency, the school environment suggests that it will not be possible to replicate exactly the type of scaffolding experienced in the parent/child situation. This should not detract from classroom scaffolding that adheres to the principles of scaffolding:

1. The learner has an understanding and knowledge of what the entire task entails at the end.
2. Help fades as the learners become competent and the teacher receives feedback.

Within the classroom situation, obviously many strategies could be considered scaffolding if they are applied in the appropriate context. Bliss et al (1994) provided a 'Taxonomy of Potential Scaffolding strategies' that can be used by the teacher when appropriate for the needs of the pupils that will be identified by feedback from both teacher and pupils if the strategies are to be effective. Bliss et al

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(1994) grouped the strategies according to their function in a lesson as follows:

Task induction management	Task
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Goal statements constraints	Specify
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Demonstrating Instructing Organization	Planning
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Facilitating through task Management	Interpersonal
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Questioning	Negotiating task and involvement in it.
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Supportive, holding strategies	Keeping on task Feedback
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Encouragement	Managing peer interaction.
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Cognitive strategies were arranged as follows:

- Explanation structures; domain specific (for example, the nature of matter)

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- Internal control and management (meta-cognition) (checking, reviewing, making notes, listing, tagging, labelling, focusing, inclusion and exclusion etc.)
- Structuring ideas or knowledge; these possibly can be customized to domain, for example, effective searching, managing evidence, testing systematically, categorizing, ordering, giving structure to narrative, identifying and controlling variables, identifying appropriate chunks with which to work.' (Bliss et al 1994)

These strategies can be applied more specifically to the classroom situation, some of which were frequently used in the Main Study. In other situations, contexts or with other pupils, different strategies may have been more appropriate but these suited the purpose of this research.

'There are several possible strategies that the teacher might employ to limit the task. These include:

- Highlighting crucial features of task, which might be ignored or forgotten by the pupil
- Using reference to earlier work, situations, activities or out-of-school experiences to show why these crucial features are important
- Analysing the task for pupils, or getting them to analyse with teacher

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- **Breaking down the task into reasonable sized chunks according to age of pupil**
- **Checking that pupils know why it is broken down into these sized chunks (that is they understand the nature of each smaller bit)**
- **Checking routines that they may need to employ**
- **Asking pupils what they do not know about the task, that is, what sort of 'background knowledge' is missing**
- **Checking constantly on pupils' understanding of what is being explained**
- **Focusing strategies: choosing what to look at and what to leave out and explaining the choice' (Bliss et al 1994).**

In schools, there may be more than one learner benefiting from a scaffold, but the elements of scaffolding must be applicable to each learner within the activity, and the assistance provided must fade when each learner becomes capable of performing the task alone. Pupils can provide the feedback to the teacher when help is no longer required during the ongoing negotiation and communication. A detailed knowledge of how children think should help teachers to be aware of when to provide and fade help.

Chapter 4.

Learning and Teaching Mathematics.

Learning and Teaching Mathematics.

It is impossible to study the learning of mathematics without exploring constructivist theories of learning, or of knowledge. These theories have defined how learners construct their knowledge and meanings. The aim of this research was to discover how children could be helped to solve arithmetical word problems, so it was important to explore theories of how children develop mathematics even though, during the Initial Study, the children who failed in these problems did so because of their failure to make use of the texts of the problems. It may have seemed reasonable to deal with this issue within the language domain, but this approach would neglect to address the critical fact that those who fail with arithmetical word problems frequently do so because they focus on the key mathematical words within the text in view of the fact that they fail to appreciate the genre of written arithmetical word problems. Their misunderstanding often results in them extracting the key mathematical words to form the arithmetical equation instead of making sense of the words of the problem. They sometimes also overestimate their own understanding of the mathematical words in the question or not appreciate all the nuances and meanings associated with these words. Although they are numerate in the sense that they can perform basic arithmetical equations, they are not aware of the importance of thinking about the meanings either of the mathematical words in relation to the text, or of how a variation in the semantic structure of the text can change the meaning of the mathematical words.

Constructivism and Mathematics.

For reasons of space I will deal only briefly with the main features of constructivism and its application to the learning of mathematics. The concern of this study is not so much a

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discussion of the types of learning theories as an explanation of how they influenced and underpinned the formation of the research in the context of how children learn mathematics.

Educational researchers are now interested in a wider area of constructivist theories. These theories emphasize the historical and social perspective of the culture upon the learner, and learning is said to occur within society with the learner as an active participant in the process (Renshaw 1998). Child development is perceived as a cultural phenomenon influenced by relationships, environment, gender, socio-economic situations and personality (Apple 1995, Caplan et al 1997). The attitude of individual learners influences the learning process partly because each must be cooperative and active in the learning process and partly because each brings personal experiences, specific gifts and talents to the learning process. At the start of this third millennium, the cultural tools are extended beyond the language and books that typified the previous century, to incorporate the tools of mass communication such as radio, television, computers and the Internet. These innovations must influence our thinking about child development because they locate us within not only our historical cultural heritage, but also in a global community, which in turn must effect our perceptions of our culture as it is viewed in juxtaposition with a wider world. This also affects the interests of children, many of who may not be so familiar with the printed word, or so used to listening carefully to the spoken word as their predecessors who did not live in a world of computer games and text messages. On the other hand, the use and development of the new technology depends upon a knowledge of language and mathematics, so these subjects still retain their important position within the curriculum.

The work of Piaget and Vygotsky is credited with providing the underpinnings of constructivist theories (Confrey 2000), which are the learning theories most associated currently with mathematics. The learning of mathematics requires the formation of concepts which occur when learners interact with their environment, (Skemp

1989) and the explanation of proof and an understanding of the learners' making sense of the ideas through reflection, which all fit in with the constructivist view of learning. Confrey stated:

'Because constructivism views knowledge pragmatically, that is, as tied to action and subsequent systems of representation, explanation and justification of that action, theorists often describe its production of mathematics as the development of tools. In addition to asserting the importance of physical tools in its development (compass, rulers, manipulatives and technologies), a constructivist's view of conceptual development emphasizes that knowledge must be inherently useful. By knowing its genesis and elaboration, one is more prepared to see the concept's possibilities relative to experience and to phenomena in the world. in general, a constructivist will view mathematics as a model of possible action, representation, explanation and justification.' (Confrey 2000).

For many practitioners, constructivism does not provide an easy approach to teaching because it is a theory of learning, or knowledge, and not a theory of teaching (Von Glasersfeld 1990). Although, in the past, teaching was concerned with delivery of lessons and the pupils, rather than the teachers or pedagogical approaches, were blamed if they did not learn, constructivism acknowledges that it is not possible to define lessons or approaches that will guarantee success within the classroom. This is because it is impossible to fully anticipate the needs of the learners or assess the previous learning of the pupils until each lesson starts. As Carpenter and Fennema stated:

'the teaching-learning process in real classrooms is too complex to be totally scripted in advance.'

(1992).

In the report of the Cognitively Guided Instruction programme, which assisted teachers to understand their pupils' thinking and respond with appropriate teaching, Carpenter and Fennema (1992) defined, within a constructivist learning theory, the types of interactions and pedagogical practices that facilitate learning:

'The critical features that distinguished CGI classrooms was that teachers listened to students and attempted to build on the students' knowledge. Understanding was important for both teachers and students. The students acquired understanding of the symbols and procedures of mathematics by connecting them to their informal problem-solving procedures. The teachers acquired an understanding of their students' thinking and a pedagogy to build upon that thinking by listening to how the students solved problems.' (Carpenter and Fennema 1992).

This prior knowledge and experience of the children, which was assessed by their class teachers was utilized during the Main Study. The children came as individuals, but they were encouraged to share their understandings and ideas and to learn from each other within a social setting. In this way, their individuality and sociability were mutually enriching experiences, one depending upon the other to increase and impart knowledge both in the language and mathematical domains.

Children construct their own understanding, but their learning is regulated by the necessity to teach them specific methods and symbols that are undeniably a response at least to the National Curricula of our countries (Scotland and England), if not part of a universal mathematical culture. This draws them into a community of practice (Lave and Wenger 1991) and into the culture of

mathematics within our society. It is part of our tradition that arithmetical word problems are given to our children; perhaps in the mistaken belief that they reflect real life situations or that these problems are important evidence of children's mathematical abilities. (Walkerdine 1988, Gerofsky 1996) No matter what real merit they may have in mathematics, they are part of our mathematical custom, just as teaching multiplication tables, using certain symbols to denote addition, subtraction, multiplication, division and equals which are all introduced in primary schools. The traditional method of introducing word problems after teaching a certain arithmetical process as proof that the children can utilize that process within the problems brings with it specific difficulties that are discussed in Chapter 2 of this thesis. Carpenter and Fennema (1992) observed:

'Teachers whose students were successful in problem solving tended to agree with the perspective that instruction should build upon children's existing knowledge rather than transmit it to them.' (Carpenter and Fennema 1992)

Confrey states that within a constructivist theory of learning;

'Although the theory stresses the need for each person to form their own understanding of a concept, it recognizes that this process is embedded in and aided by social and cultural relations. Tasks and problematics are mediated by cultural distinctions and defined through social interactions, both peer-to peer and teacher-student. Acceptable and likely forms of actions on objects are influenced by one's view of those objects as cultural tools. Methods of representation, the language of description, representation are profoundly influenced by the intellectual resources of the environment.

Communication with others is essential in explanation and justification. Self-regulation is often achieved through the internalisation of a scheme as a result of assessment of one's satisfaction of a felt-need, often governed by interactions with others.' (Confrey 2000).

While teaching children to solve arithmetical word problems in the traditional manner, frequently with an over-emphasis on the use of the key mathematical words, may be considered to be an induction into a community of practice, this did not accurately describe the aim of this research. The children were encouraged as individuals to share their understanding of the stories in the light of their experiences and within a social setting, but the methods employed to find an arithmetical equation to solve the problems accurately did not belong to a traditional community of practice. There was an emphasis on the social context because this provided the opportunity for individual learning as each listened to one another and contributed to each other's learning. There has been some debate within constructivism about the overemphasis of the learner as an individual; and the term 'socio-constructivism' is used to differentiate between the individual Piagetian learner and to identify the learner who is an individual constructing his or her own learning within a community. Confrey dismisses this division as unnecessary:

'It seems obvious to me that since knowledge requires justification the need to differentiate socio-constructivism from constructivism disappears. Although I understand that the term "socio-" was appended by Cobb, Yackel and Wood (1991) to overcome the constant criticism of critics of constructivism that the theory was excessively individualistic, I find their decision unfortunate. The theory of constructivism has always been social - for it has always recognized

the importance of social interaction - relative to task construction, to the choice of action or interaction, and to the development and use of systems of representation, description, explanation and justification. The insertion of "socio-" created a distinction within our community that rent the fabric of constructivism unnecessarily.' (Confrey 2000).

Therefore, the constructivism, which underpinned this research and was defined by Confrey, (2000) can be summarized briefly as follows:

1. Although we act within our culture, each, as an individual, must make sense of every idea through action and activity in acts of learning.
2. Learners can claim to have acquired knowledge through acts of learning only when they reason and argue their knowledge; that 'it can be justified.' (Confrey 2000)
3. Knowledge develops and there can never be an assurance that the knowledge we have today is true knowledge because it will develop as we increase our experiences.
4. Most learning occurs with the desire to seek a solution to a problem.

During the Main study, the children themselves were permitted to use whatever constructs they decided were appropriate for a solution to the word problems. The fact that many chose to form an arithmetical equation using a conventional format taught in their classrooms could be interpreted as a drawing into a community of practice where they were taught the use of symbols and a specific way of writing sums. (Lave and Wenger 1991). Moreover, the use of arithmetical word problems, which are traditional in our society, in one sense drew the children into a community of practice. Confrey (2000), however, states that within a constructivist view of

learning all such cultural practices are part of the learning process.

A CLARIFICATION OF 'UNDERSTANDING'.

The problem solver must have a sufficient understanding of the processes of addition, subtraction, multiplication and division to appreciate their applicability to the various problems. However, the definitions of the word 'understanding' in this context is a matter of some debate and requires clarification in its use in this thesis in several details, such as

- how it is used in the context of learning, and
- how it is used in defining the extent and depth of that learning.

Skemp (1989) considers that in mathematics even the word 'understanding' has two meanings:

- Instrumental understanding: rules without reason.
- Relational understanding: knowing both what to do and why.

He compares the difference in the two types of learning with his own way of coming to grips with the layout of a certain town where he had never lived until he went to work there. He had two goals:

1. To discover the particular routes between where he was staying and working, the university refectory where he ate and a few other places he frequented.
2. To gain a good knowledge of the town and to discover anything of interest to him in the town.

The first goal required the memorizing of certain landmarks which would assist him to reach his destination quickly but with no true knowledge of the town's layout, its places of interest or any features which would have been of special interest to him. This is likened to **instrumental knowledge** of mathematics. The child is taught a formula to find the answer without an understanding of the mathematical processes. The child who has instrumental understanding of a task will be able to execute that task before progressing to instrumental understanding of the next type of tasks. As Skemp (1989) said:

'There is no awareness of the overall relationship between successive stages, and the final goal. And in both cases, the learner is dependent on outside guidance for learning each new way to get there.' (Skemp P16).

Skemp's (1989) second goal was to increase and consolidate his knowledge of the town. He learned about the places of interest, the civic amenities and the recreational facilities to the extent that he could use them to serve his own daily living requirements, interests and recreational needs. This corresponds with **relational knowledge** of mathematics in which the child has an understanding of the processes and is able to find his own ways of reaching the solution. The child who acquires relational mathematics can build up a conceptual schema that can be the basis for producing other schema. There is such a difference in the outcomes of relational and instrumental mathematics, that Skemp (1989) states that if he played Devil's advocate, he would state that it is difficult to decide whether the two are indeed separate subjects, or different ways at looking at the same subject (Skemp 1989). To summarize, children who do not have relational understanding have been trained to carry out each arithmetical process successfully (Jaworski 1994). Their success is confined to producing the correct answers to exercises that develop their abilities in the particular processes being taught, but they fail to appreciate their applicability to specific situations such as arithmetical word problems. When they are taught each process, they will use that successfully but without the realization of the link and interchangeability with other processes because they are not in full possession of the process. They have procedural knowledge of the strategy because they know how to use it, but they have not developed the necessary conditional knowledge necessary for knowing when and how to apply the tactics and skills of the arithmetical processes (Phye and André 1996). This is because, as Whitebread (1995) states,

'The teaching of 'pencil and paper' strategies for tackling certain kinds of mathematical problems is all too often done in a way which does not encourage children to reflect upon the processes involved, so that they can become in control of the new strategy.'

(Whitebread 1995)

Children with relational understanding can utilize the various arithmetical processes competently and have the ability to independently employ their knowledge in new situations such as arithmetical word problems. They are free to develop their own approach to work because they recognise the association between all the processes. When these processes are interchangeable, children with relational understanding choose, with confidence, the process they find easier or more convenient in each context, and are unfazed by the fact that a peer may be using the alternative process. For example, when presented with a problem solvable by the arithmetical equation of sixty-seven minus thirty-eight: $67-38$, one child may choose to subtract the thirty-eight from the sixty-seven while another may count on from thirty-eight up to sixty-seven. Similarly with multiplication sums, one child may choose to use knowledge of multiplication tables while another may use the process of addition to reach the answer. Either the multiplication tables may be utilized or subtraction may be an easier choice in division sums, depending upon the learner. Comparing relational understanding with instrumental understanding highlights the diverse outcomes in learning experienced by children. Although training in instrumental understanding of the arithmetical processes provides visibly successful instant results because the children know how to do the sums, this is not teaching for the perceptivity in mathematics that will equip the learners to apply mathematics to mathematical problems they will encounter in their daily lives. (Dehaene 1997, Hughes et al 2000). There is clearly a difference between training for instrumental understanding and teaching for relational understanding. This difference can be addressed in both the curricular content and in the pedagogical approaches, (Askew

1998, Hughes et al 2000) but to do so effectively, the children themselves must be active participants in the learning process. The stories used in this research were intended to hold the interest of the children and keep them in communication with the meaning of the text, with the teacher and with one another. The text of the stories was lengthier than the typical arithmetical word problem. The fact that the children had to think about this text in the language domain was intended to contribute to their relational understanding of the use of text in written arithmetical word problems.

To provide successful scaffolding, learners must be willing to cooperate with the teacher or more competent peer and be keen to interact with the goal of learning. Confrey (2000) describes this as 'a perturbation', which he says is a 'felt need'. Otherwise the learner really wants to know, to find the solution to the problem.

'Creating effective tasks that embed significant concepts in a problematic, to explain their genesis, and provide a reason for their birth and endurance is key concept of constructivism' (Confrey 2000).

Although each must form their own concepts as individuals, this occurs within social and cultural contexts and it is here that constructivism offers the possibility of scaffolding. In her paper 'Constructivism and teaching - The Socio-cultural context.' Jaworski (1993) presented her theory that many classroom situations, which were identified by researchers as constructivist, should be more accurately described as socio-cultural. It is possible to acknowledge, without debating her arguments, her identification of the role of the teacher within constructivism (or the socio-cultural context). She states that

'This is reminiscent of Bruner's work on scaffolding, with the teacher performing the role of 'consciousness for two' (to do for students what they cannot yet do for themselves) in relation to

METACOGNITION.

To learn effectively, the learners themselves must be conscious of their own learning skills and be sentient to all aspects of learning as an active participant in the process with the more knowledgeable teacher or peers providing help and information when appropriate. The learners themselves must become aware of their own personal preferred styles of learning such as visual or oral, and be prepared to utilize materials that aid them to acquire knowledge and understanding. Mathematics does not require a particular type of intelligence, but children need to be taught to use their intelligence in a particular way to make the leap from concrete practices to abstract thought. (Skemp 1989 and Pimm 1995) The greatest hindrance to learning mathematics is the attitude of the learners who perceive mathematics as being abstract and are aware of their own difficulties with abstract thoughts. (Fisher, 1995, Hughes 1986, Skemp, 1989 and Thornton 1995). When children reflect on mathematical processes, particularly their own, and are involved in dialogue about mathematics a more positive attitude towards an understanding of mathematics can be fostered (Fisher 1998). It is difficult to define metacognitive processes precisely because so much research is being conducted in that area, (Hacker et al 1998) but if metacognition is accepted to be an understanding of one's own thought processes, then children should be taught to consider how they themselves think about and approach their work, because it is only when people know the state of their own knowledge that they can direct their own learning to what they do not know.

'Metacognitive skills help the student

- a) strategically encode the nature of the problem and form a mental model or representation of its elements,

- b) select appropriate plans and strategies for reaching the goal, and
- c) identify and conquer obstacles that impede progress.' (Hacker et al 1998)

It is when children develop an awareness of their own thought and learning processes that they can be helped to make adjustments to them, if necessary and progress to a deeper understanding of their work.

The children who participated in the Main Study were given a printed version of the stories that all had some aspect of mathematics in them, which were read aloud by various children within the group or class, and each part was discussed in detail. In this way, it was hoped to access the various learning methods employed by the children.

LEARNING CONCEPTS.

It is widely accepted that learning develops through the formation of concepts which we, as individuals, build up from our experiences within our society. Although there are various definitions of the word 'concept', Howard's (1987) definition is;

1. A concept is a mental representation of a category, which allows a person to sort out stimuli into instances and noninstances.
2. Concepts can be formed by abstracting information from instances.' (Howard 1987).

We use concepts to organize all our experiences and relate them to each other otherwise each experience would be unique. We abstract the essentials from each experience and add that essential knowledge onto what we already know. Eventually most of us have had a sufficient range of experiences within our own culture to relate new ones within that culture to our existing knowledge. Therefore, the abstractions of various individuals from one experience will not be identical because their previous experiences, which they are building

on, or adding to, are unlikely to have been the same. Nevertheless, there must be some similarity between the new and past experiences for new information to be absorbed. Meadows (1993) stated,

'To put it in a Piagetian way, we cannot assimilate information unless there is something to assimilate it to; to put it in a mainstream American way, we need a reasonable degree of match between what we already know and what we have to learn.' (Meadows 1993)

Frequently a cluster of concepts is defined as a 'schema' when, for instance one whole is made up of parts. For instance, the schema for 'face' consists of all the concepts of a face such as the mouth, the ears and all the body parts associated with a face (Howard 1987). Although it can be argued that each of these parts should be defined as a schema as each has several medically identifiable parts to aid its function, such refinements in the use of the words are not the concern of this research. In the literature, frequently both the words 'schema' and 'concept' are either identical or have minor shades of differences in their meaning so they will be considered as interchangeable in this thesis. For instance, Dochy's (1992) definition of 'schema' resembles Howard's (1987) definition of 'concept':

'A schema is a basic unit of the knowledge structure, a construct which refers to the format of organized knowledge. It is a fundamental element upon which all information-processing depends. We can imagine it as a unit in which knowledge is packaged.' (Dochy 1992).

Young children will build up concepts of, for example, dogs by observing numerous dogs until they have established sufficient characteristics of dogs in their minds to recognize dogs no matter what diversity of breeds they encounter. In the formation of concepts,

abstraction is the process by which we become aware of regularities in our experiences and concepts are mental embodiments of regularities in our experiences. Primary concepts are derived from sensory experiences while secondary concepts come from all other experiences. New concepts cannot be communicated directly as each learner has to construct them in his own mind, but a tutor can help. If the new concepts are of the same order, or lower order than learner's schema, an explanation is sufficient. If the concepts are of a higher order, some carefully chosen examples of the new concept are necessary to enable the learners to begin the process of forming the concept in their own mind (Piaget, 1941 Vygotsky, 1978 Skemp, 1989). New knowledge generates a greater depth of knowledge because children draw inferences from similarities between what they already know, (Thornton 1995) and each new inference depends upon the knowledge already acquired. Jaworski (1994) considers that

'every new encounter either adds to the experience or challenges it. The result is the organization for each person of their own experiential world, not a discovery of some 'real' world outside.' (Jaworski, 1994.)

Thornton (1995) states that inferences depend upon experiences, so a teenager and a toddler will make different inferences because of the knowledge they already have acquired in their experiences. This diversity of experiences can be the cause of a lack of understanding of e.g. the texts of arithmetical word problems. The readers and the writers may not share experiences to an extent that permits a commonality of opinion on the meaning of the texts. This had to be addressed in the research reported here. The discussions of the texts, which were undertaken during the Main study, ensured that the children developed a shared meaning of the texts even though they had started out with different understandings depending upon their experiences. For example, in one of the stories in the Main Study, 'Jeremiah', Gran was said to have gone, but there was no specific reference to why or where and the children came up with various

suggestions that were influenced by their own personal experiences as the following extract shows.

R. What do we know about Grandma now?

V. She's died.

R. Does it say she's died?

Gr. No, it says she's away....

N. She may have left him....

R. That's true Natalie, but what does it say on the paper?

R. Thomas. She's left him...It says that she had left. She could have died, or left Grandad or gone on holiday.... It doesn't say, but there is a clue that she did not just go out to somewhere like the local shop...Is there a clue?

S. She wasn't there when Grandad gave the programmes away.

R. yes. And who's house did they go to after school?

Gr. Grandad's.

. Grandad's.

R. Yes, it doesn't mention Gran then. So we have a clue that she is away for a long time but we don't know any more than that.

Reading from text.

R Do you have to watch everything you say in front of your Grandparents?

Gr. sometimes.. it depends...

R. What does this mean? No peace? Trouble for all? What sort of person do you immediately imagine grandma is like?

Gr Bossy, tells them what to do.

? Mean.

R. Does it say that she is mean?

Gr. No.

R. So we don't know, we just wonder.

N. Maybe she is in a wheelchair and they have to be careful when she is around..

R. Yes, but we don't know yet. Read on Bill.

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B. Reading...flicked her fingers....

R. What do you think of Gran now?

Gr. She's nice, good, like her...

R. So you've changed your opinions, have you?

Children need to be helped to awareness that new knowledge is connected with their present knowledge.

'The more abstract the schema becomes, the greater the difficulty in constructing it, and thus greater the need for help. Effective help of this kind becomes essential if we want children to acquire, in ten or fifteen years, knowledge which it has taken the best minds of mankind centuries to construct. Fortunately, the right kind of teaching can greatly help the construction of mathematical schemas. Unfortunately, as we have seen, the wrong kind can put people off for life. The fact that this help is necessarily indirect makes a teacher's task more sophisticated.' (Skemp 1986, 1995).

In other words, the teacher must be capable of teaching after considering the knowledge of the children and making

'informed decisions rather than by attempting to train them to perform in a specified way.' (Carpenter and Fennema 1992)

If teaching is well planned, the progression should be continuous and this helps the learner. When teachers have knowledge of how children think and solve problems, then they have the basis for building programmes of work that will help them to construct knowledge (Carpenter and Fennema 1992).

MATHEMATICAL LANGUAGE.

Mathematical discourse uses words that frequently have a different meaning outside a mathematical context. (Walkerdine 1988, Hegarty et al 1995, Pimm 1995) *More* and *less*, *odds* and *even* are examples of such words. Children arrive in school using these words and teachers assume that they understand the meaning of them in the mathematical discourse. For instance, Stern (1993) whose research was discussed in Chapter Two, states that some children do not have an understanding of 'more' and 'less'. Walkerdine (1988) recounts one teacher's experience of teaching a lesson on odd and even numbers where the children booed the odd numbers and cheered the even. The only explanations offered for their bizarre behaviour were the pejorative connotations attached to the word 'odd' in non-mathematical discourses. Walkerdine (1988) states that relational terms, which are important for mathematical practice, are used in very specific contexts within the home. School mathematics uses *more* and *less* as a contrastive pair and the children's failure to understand the meaning of these words is assessed as a failure to understand quantity relations. However, Walkerdine (1988) argues that many children have practice in quantitative relations in the home but use the words *a lot* and *a little* to express the differences. The word 'less' did not feature in the conversations of the children in her research. As she states:

'While there were in the corpus inspected many instances of more and none of less, it is important to point out that the term more was not used in practices involving the contrast of quantity relations. More was used almost exclusively in the regulation of consumption by parent and the children's request for extra helpings. In these practices the opposite of more is not less, but something like no more, since the opposite of more pudding in such examples is clearly not less pudding.' (Walkerdine 1988)

This confusion with the language of mathematics continues for some children beyond the early stages of schooling. Pimm (1987) reports the following question and two of the responses. The content of the question suggests that the children were not in the first year of the primary school and indicates a lack of comprehension of the mathematical use of 'difference'.

Question. What's the difference between 24 and 9?

Response 1. One's even the other is odd.

Response 2. One has two numbers the other has one.
(Pimm 1987)

The research was originally planned to help children to do written arithmetical word problems by helping them to understand the meaning of mathematical words. This was to overcome the misunderstandings associated with those words that may have been rarely, if ever, used by the children and to develop an understanding of these words. The Initial Study identified the source of the children's difficulties with their interpretation of the text of the problems, but this did not lessen the need to use these words in contexts that would help the children to understand them or offer the opportunity to explain their meaning. Because of this, some of the written arithmetical word problems presented to the children during this research were composed to address this issue of confusion over the meaning of the words 'more' and 'less'. These words confuse children, particularly when the semantic structure of the word problem does not easily convert to a written equation. This issue has been discussed in aptitude to progress to oral or written arithmetical equations, the children themselves fail to connect these activities with such work (Perlmutter et al 1997, Walkerdine 1988).

Implications for the research.

Although there are many definitions of constructivist, socio-constructivist or social-cultural theories of learning mathematics, I chose to view the learner as one who as an individual develops mathematical concepts within society. The individuality aspect is

Chapter 4. The Learning and Teaching of Mathematics.

defined by our personal experiences and uniqueness, but we are all members of society and it is within the culture of that society that we learn. The scaffolding techniques identified in the chapter on the Main Study assisted the learner as an individual. The knowledge of the children was used as a base to build upon because the children had the ability to read and could perform arithmetical equations. They were helped to organize and expand this knowledge to become successful problems solvers. The social context of the learning process is very important and each child shared and acted upon the ideas and knowledge of their peers and teacher.

Chapter 5.

The Initial Study.

The Initial study.

The original plan for the research had been to scaffold the teaching of the arithmetical word problems in the mathematical domain by increasing the difficulty of the problems until the children were competent problem solvers. Thus they would be introduced to simple problems that were little more than a sum written in words such as this combine problem:

You have 3 red pencils and 5 green pencils.

How many pencils is that altogether?

The semantic structure of the problem is so simple that it would be very difficult for the child to fail. The word 'altogether' would give a contextual clue that the arithmetical equation was addition, so this eliminated the one mistake that could have been made by the children, namely subtracting. When the children had demonstrated their competency at this level, they would move on to the next stage which would have introduced more words in to the text:

Victoria and Matthew are counting their pencils. Victoria has 12 pencils and Matthew has 5 pencils. How many do they have altogether?

Eventually other numbers would be introduced which would be unnecessary for the solution of the problem:

Rachael, Victoria and Tara are counting their pencils. Rachael has 17 pencils, Tara has 3 pencils and Victoria has 12 pencils. How many pencils do Rachael and Victoria have altogether?

The children would follow a similar induction process for the change and compare problems until they all knew how to solve all of these types of problems. The plan at the early stages of the research was to devise a bank of problems that the children could work through as individuals, practising each type and degree of difficulty of the problems until they demonstrated

competency at all levels. The role of the teacher was to provide help when required at the start of each new type of sum and new level of difficulty, and to withdraw that help when the learner was assessed as competent. Therefore, the children would be scaffolded by the teacher's assistance and by having texts with an increasing level of difficulty given to them. The original proposal was to have a particular emphasis on the language of mathematics, specifically on the key words in the text of the written arithmetical word problems. Key words such as 'more', 'less' and 'altogether' can cause difficulties for children when they encounter them in arithmetical word problems, therefore it was imperative that the children should be taught the meaning of these words in a mathematical context.

It was decided to conduct an Initial Study to explore children's responses to arithmetical word problems. Analysis of the children's approach would indicate how scaffolding techniques could be best utilized to assist them to formulate the correct arithmetical equations to solve the problems. A detailed examination of the arithmetical equations formed by the children was intended to uncover any patterns of errors that could be attributed to particular types of problems, or specific erroneous formulae used by the children for the arithmetical equations. The results of this study were intended to suggest the details for the writing of the arithmetical word problems that were to be used to scaffold the children's learning.

RESEARCH METHODS.

Eight children, four boys and four girls, in a primary three class whose ages ranged from six years and ten months to seven years and eleven months took part in the initial study. The children had an emerging ability in arithmetical word problems in that they had been introduced to them in the school mathematics scheme, so they were already aware of the need to use information in the text of the problem to form an arithmetical equation. However, any experiences of written arithmetical word problems were limited

to those in the school mathematics scheme, which were presented as an assessment of ability in an arithmetical process.

The class teacher had been consulted about the requirements of the study: namely that the children should have the ability to do the arithmetical work of the written word problems when given to them in sum (equation) form, and that they should be able to read sufficiently well to permit them to understand the texts of the problems (Lewis 1989). The parents' permission was sought and readily given for the children to take part in the study. They were all moderately competent readers for their class group and had sufficient computational skills to take part in this study, although their levels of competency in both the mathematics and language domains varied. During a preliminary session, all the children who were to take part in the initial study were given a selection of arithmetical word problems to ascertain their level of competency in reading and number work. It was apparent that some children had difficulty reading the words for numbers, so numerals were used in the study. E.g. 19 was used instead of 'nineteen' throughout the study.

The Initial Study comprised of two tape-recorded sessions with each individual child. Notes were made of all the reactions of the child such as eye movements, gestures, comments and questions. During the first individual sessions, each child was given typed arithmetical word problems, but for the second individual sessions the problems were presented on tape. The tape recorder was simple to use and the children could use it themselves or ask for assistance with the controls. Therefore two tape recorders were used for these particular sessions: one which I had always used to record all the interviews with the children, and the second tape recorder, for the children to operate, which had the tape of the recorded arithmetical word problems. At the time I had considered the difficulty experienced by the children to be situated solely in the mathematical domain. Therefore, I decided to use the recorded arithmetical word problems to facilitate their solution by removing the difficulty of reading the text of the problems. The vocabulary used was assessed as appropriate for their reading level and the font for the written arithmetical word

Chapter 5. The Initial study.

problems was similar to the print in their school reading books, as it was important to minimize any difficulty with reading and interpretation to allow the children to concentrate their efforts on solving the problems.

Three types of problems were given to the children - two each of compare, change and combine were written for the first session and again two each of compare, change and combine were recorded for the second session.

Compare:

The postman has been busy bringing all the Christmas cards to your house. You have to find a place to put them all up. You and your mum are counting the number of Christmas cards you have been sent. Your Mum has 15, but you have 23. How many more cards than your Mum do you have?

Change:

It is almost Christmas and you are putting up the decorations on the Christmas tree. You found a box with 17 decorations left over from last year. You put them on the tree, but there are still lots of empty branches. Then your Mother comes in with a packet of 24 new decorations in a bag. You chose 9 silver ones to put on the tree. How many decorations do you have now?

Combine:

The school is going to give a Christmas concert on three afternoons for the parents. Some old people are coming for the rehearsal. Two children in your class were told to put out enough chairs for all the visitors and the teachers. One child put out 19 chairs and the other child put out 9. They asked the janitor if that was enough. He said,

'How many chairs have you put out altogether?' What did they tell him?

The problems were presented in a random order in an attempt to prevent the children from assuming that all of the problems were of the same type. The questions were set in the familiar contexts of various school activities featuring other children in their class (d'Ailly et al 1997). Two of the combine problems had other numbers introduced that were not required for the correct arithmetical equation to find the answer to the problems. This was to discover if the children were using all the numbers in the written question to form an arithmetical equation rather than rely on the meaning of the text to form the equation. All the sums were either addition or subtraction to fit in with the children's class work. Care had to be taken with the order of presentation of the numbers in the written problems to discover if the order influenced the children in their choice of arithmetical formula to solve the problem. For instance, subtraction sums are written with the higher number first in the format which is familiar to Primary 3 children. E.g. $9 - 4 = ?$

Discussion.

The primary purpose of the Initial Study was to discover the various aspects of the children's approach to the arithmetical word problems. At that time there were specific research questions such as:

1. Did the children use the key mathematical words in the text of the questions to suggest the formation of an arithmetical equation?
2. Did they use all the numbers in the text to form an arithmetical equation?
3. Did the order of the numbers in the question influence the children in their formation of the arithmetical equations?

The various strategies and approaches that the children used when tackling these word problems were an important part of the initial study because they would indicate the source of the children's difficulties with these problems. It was intended to write arithmetical word problems that would gradually

introduce the language of mathematics to the children and address any other difficulty uncovered by the initial study. Thus having various difficulties introduced and explained gradually would scaffold the children's learning. It was planned to write a collection of word problems that would provide a bank of problems accessible to teachers who would use only those which provided assistance for the specific difficulties of individual children. Therefore, children who had failed to grasp the use of the word 'less' in a problem such as:

'James has 5 apples. He has 3 less than Catherine. How many apples has Catherine?'

would be given arithmetical word problems introducing this use of the word 'less'. These children would not need to be given extra practice in arithmetical word problems where they were assessed to have no difficulty. If children were observed to be confused with some aspect of computation during the initial study, then help would be given to them because computational skills seemed to be very necessary in solving arithmetical word problems.

The individual approaches.¹

It became apparent in this study that the success or failure of the children in solving arithmetical word problems lay with their interpretation of the text. Their competency in arithmetical processes determined whether the final answer was accurate or not. However, there were some children who could never have arrived at the correct answer to some of the word problems because they could not decide on an arithmetical equation by using the information in the text. There was one child in this small study who managed to form the correct arithmetical equation for all of the word problems but who

¹ In the following extracts from the transcriptions of the tapes of the recordings of all interviews in the Initial Study, the letter at the beginning of the line replaces the pseudonym of the child and R indicates me, the researcher. The children are from Glasgow and the phrasing of questions and conversations often depict a way of self-expression that is sometimes recognizable as typically 'Glaswegian'.

had such difficulty with addition and subtraction processes that she rarely managed to produce a correct answer. A future recommendation for this child, Kate, is to permit her to use a calculator for word problems, but the purpose of the initial study was to identify difficulties in the mathematical domain and her difficulties at that time were with computation. Nevertheless, on reflection on all the data at the end of the initial study, Kate was considered a successful problem solver because of her accurate interpretation of the text. The children in this initial study used words such as 'more' and 'less' as clues for the formation of the arithmetical equations but their application of these words were often inaccurate. The final analysis of the data and a search of the literature indicated that a more pragmatic approach would be to teach the children to interpret texts in the language domain. It was clear from the data that those children - Michael, Meg, Susan and Kate - who were successful problem solvers, were those who used the text of the question to formulate their arithmetical equation. They could explain the text in their own words and say why they had chosen to use some numbers and reject others. They did not use the key mathematical words to form the arithmetical equation without consideration of the whole of the text of the problems. Sometimes they used their own semi-colloquial words instead of the words in the text to articulate their thinking.

Michael consistently solved the problems correctly. He could explain his approach when questioned. Sometimes he gave an answer without any outward sign of thinking, at other times he could be seen to be calculating an answer as he used his fingers accompanied by body jerks to count. Michael either remembered the number bonds, that is the answers to simple additions, or used his fingers to help him to add. He always added from the lower number up to the higher. He had a very good understanding of arithmetical processes because he explained that in compare sums he chose either to add on or subtract 'both of them are the same'. His choice varied and was influenced by whether he found it easier to add or subtract the numbers in each sum. Therefore, if he could subtract without decomposition he did so, otherwise he frequently added on from the lower number. He said he preferred

to have the sums written rather than recorded and he was the only child who wrote down numbers to help him to remember the answers during the recording. He used his jottings to help him to form an arithmetical equation when the tape with the recorded problems was turned off to give him time to solve the problem. He did not abandon the reality of the situation and could interpret the text and what was being asked in his own words. Frequently, he became a little exasperated when he was asked to provide an explanation for some process that he considered being logical. This extract demonstrates his puzzlement when he was being questioned on his reason for leaving out the number 24, which was not required for the solution of the problem.

M. *Read arithmetic problem with no difficulty, laughing at the mention of his Mother in the text. He used fingers accompanied by body jerks to count from 17 and stopped at 26.*

Twenty-six.

R. Are you sure?

M. Yes.

R. How did you do that?

M. Seventeen and the nine and I left over the twenty-four.

R. Why did you leave over the twenty-four?

Appeared confused at reason for questioning about 24 and raised his eyes and sighed. He seemed to be exasperated about the need to explain.

M. Well ... I just....(sigh) See if.. Say my Mum already had seventeen decorations and my Mum came in with a box of twenty-four new decorations, so I choose nine and I left out the others. And that gave me twenty-six.

Sometimes Michael chose to re-enact the text of the problems as he read them and thought about the situation described in the text:

Read the text as though visualizing the situation with little body movements 'placing' the imaginary children and the janitor on different parts of the table. Used finger movements and body jerks to count.

M. Nine(counting silently) Twenty-eight.

R. And how did you do that?

M. I used the big number, which was nineteen, and I added on the nine.

R. So is it an adding up sum?

M. Yes.

R. How can you tell it is an adding up sum?

M. Because you cannae take nine away from nineteen, can you?

R. Yes you can. You could have nineteen chairs and take nine away.

But what is it asking you?

M. To add all of them.

R. How do you know it is an adding on sum?

M. Mmm.

Looked at text, focusing on numbers.

R. How do you know you had to add those two numbers together?

Michael was still scanning the text, but was now looking at all of it, not just the numbers.

R. What were the children actually doing?

M. Well, they were putting out enough chairs for the visitors. *Scanning text and using gesticulations to articulate actions. He spoke very slowly and maintained eye contact while explaining his reasoning to me.* And one put out nineteen and the other put out nine. So if one put out nineteen.....if you take nine away...you would be leftwell some of them would be standing. If you added on the nine, all of them would be sitting.

Meg and Susan, both very fluent readers and both successful problem solvers, also preferred using the written text and had to listen to the recordings several times. Meg asked for confirmation of the numbers in the recorded text. She identified the correct ones, but needed reassurance that she had the correct numeral:

Q.3 'M. Is it one rubber, two pencils?'

Q.6 M 'Nineteen?'

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Meg used her fingers or counted mentally when she had the written text in front of her, but she asked if she could use cubes for counting the first recorded problem and continued to use them throughout that session. When she listened to the recorded sums, she asked to use cubes to find the answers for four out of the six sums as though she needed some visual representation of the words (Pimm 1987). At the end, when asked which problems she preferred - the written or the recorded ones she replied;

M . 'The ones I see written because they're a wee bit easier for me.'

Meg had no difficulty in discarding the extra numbers put in two of the combine sums although she could not explain how she was going to tackle this sum and stared into space as though visualizing the problem before she produced the correct answer using cubes.

Question six.

R. What are you doing?

M. I am counting out counting up the sixteen and the nine.

R. What are you doing to them?

M. Sixteen add nine. Sixteen, seventeen, sixteen, seventeen...twenty-five.

R. How did you know that was nine you added on there?

M. I did four and four and one.

R. Yes, but how did you know it was four? I didn't see you using your fingers or anything.

M. I used my fingers. *Meg demonstrated an almost invisible movement of her four fingers. She does not use her thumb for counting.*

Meg had developed her own approach towards counting with the number five because she never used her thumb, even though there was no physical reason for this. In question three she had identified the numbers that were required for an accurate solution, but she seemed to hesitate instead of proceeding with the solution. I encouraged her to start:

R. How are you going to do it?

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M. I am going to take thirteen then add on four and four.

R. Is this an adding or subtraction sum?

M. Add on.

R. Good. Write the answer down.

M. twenty-one.

R. Do you always add four and four?

M. Yes.

R. Do you find four an easy number to add on?

M. Yes

R. Do you never do it with five?

M. I count the four on for fives, **then** add the one.

M. If it was something like thirteen add on five, what would you say?

M. Thirteen add on five.

R. You would do the five then?

M. Yes.

R. If it was thirteen add on seven, what would you do?

M. Thirteen and four and two and one.

R. Who taught you to do that?

M. No one, I just thought about it.

Susan invariably glanced at the text of the question, apparently quickly rehearsing the reading before reading out loud. On one occasion she replaced the word 'children' in the text with 'kids' when she read it, suggesting that she was putting the text into her own words as she read. When she listened to the recorded questions, she always asked to hear the question again or checked with me if she had heard the correct numbers. She used an imaginary number line to count:

R. When you are staring at the paper, what do you imagine you are doing?

S. Just watching it to see if I am right or wrong.

R. How can you see?

R. By just imagining the numbers along the line.

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R. I wondered. I saw your eyes moving as though they were going along a number line. *Susan's head nodded at each number and her eyes moved along as though following an imaginary line.*

Kate was unique in the group in that she formulated the correct arithmetical equations, but invariably made a mistake with her basic arithmetic. In this extract from the transcripts, she is explaining how she is going to find the answer, but there is no mention of rows of chairs in this question, which is about the required number of chairs for the school concert. She had translated the text into her own words:

K Add on the back row then the next row then the next row.

R. In the hall?

K. Yes

R. Which numbers tell you how many chairs were put out in the hall?

K Nineteen andTwenty-four.

R. Did you use your fingers?

K I started with nineteen and I used my fingers to add on nine. *Kate had again forgotten to count the fingers on one of her hands.*

Joe was not a very fluent reader, but he seemed to know that the solution to the problems lay within the text. He scanned and rescanned the text and thought about it. He frequently asked for some sort of assistance in reading the problems, such as asking what a particular word said, and sometimes stated that he did not know what the text meant. Short discussions of the text, which permitted him to put the text into his own words, seemed to help him to clarify any confusion. He formed equations for the recorded word problems without any bother and it seemed that his difficulty with the written word problems were caused by his hesitancy in reading and a tendency to lose the track of the text. He worked very quietly and did not give much indication of how he was deciding how to form the arithmetical equations. When he was questioned about his methods and why he had correctly added particular numbers, his replies were a revelation.

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Joe. Fifteen. Two. Two more. Will I write two more?

R. Yes. Or just write two. Can I ask you how you knew to do it that way?

Joe. Because fourteen and sixteen is easy because you just miss out one number.

R. How did you know to do that and not add up fourteen and sixteen - add them together - the fourteen and the sixteen?

Joe. Because that would take longer.

R. And that is the only reason you knew?

Joe. Yes.

R. Was there anything in the words that gave you a clue? None of the words told you that you hadn't to add the fourteen to the sixteen? Why did you not do: fourteen add on sixteen?

Joe. If I added on fourteen add on sixteen it would take even longer.

R. It wasn't because of any of the words?

Joe. No.

R. Like 'more than'?

Joe No.

Analysis of the transcripts of Joe's interviews confirmed that he was using a combination of the key words in the text to choose either the addition or subtraction format, coupled with the assumption that the sums would not be too difficult. Therefore, when he had a choice of numbers, he decided to subtract if the numbers would have taken him too long a time to count. His method did not always work during this study. Joe's arithmetic was accurate, though in this instance it was negated by the wrong arithmetical equation. His misunderstanding developed from his inability to interpret the text accurately, causing him to fail to construct the necessary arithmetical equation.

Joe had a struggle with some words in the text, and was much less fluent a reader than Michael, Susan, Meg or Kate. However, Jim was such a hesitant reader that he had difficulty decoding many of the words and interpreting the text. I had to read the words he found difficult to try to maintain the meaning of the text. However, his poor decoding skills were not solely to blame for his

inaccuracies. His failure or success in the arithmetical word problems depended on the complexity of the text. When the text was written, he used the written numbers to form an arithmetical equation. When it was recorded, he was obviously listening for the numbers rather than paying attention to the text. Nevertheless, like Joe he was very quick with his addition and subtraction and he was invariably correct, but the numbers and processes he had chosen were not always the correct ones. He did have a very good understanding of the arithmetical processes and used all sorts of short cuts to reach an answer quickly. In this quotation he is describing how he adds numbers with the digit nine in the unit place.

J. Add them two. *Pointed to nine and nineteen.* Twenty-eight. *Jim did not use his fingers as he had in the previous sum.*

R. Good Boy! Did you just know that answer?

J. Yes. You go one back.

R. One back? When do you go one back?

J. Nine is nine and nine add on nineteen is twenty - eight. So you go one back.

R. Oh, I see what you mean. Is this just when you are adding on with nine?

J. Yes.

In order to establish the importance of the interpretation of the text for this research, Jim was assisted with his interpretation of the text of the arithmetical word problems. His accuracy in the answers improved and this confirmed the importance of interpretative skills for the solution for these arithmetical word problems. Kate had interpreted the text accurately, but did not have the necessary computational skills to solve the problems. Michael, Meg and Susan had both the interpretative and computational skills. Jim had the computational skills and when helped with the interpretation of the text, he succeeded with the arithmetical word problems.

Rose, the twin sister of Susan, preferred to listen to the problems and was not as fluent a reader as her sister. She had some difficulty with the arithmetical

word problems when they were printed but she listened to the recorded ones and identified the correct numbers to use in the arithmetical equation, even when there were extra numbers put in. However, in the written problems, she scanned the text for the key words rather than read the whole text and used the key words with the numbers in the text to form an equation.

David read the text of the questions without any difficulty whatsoever, but with absolutely no attention to the punctuation. He was an excellent decoder of the words, but could not explain any of the text of the questions in his own words. He made it very clear that he wanted to complete the problems without any interruptions. When he was asked how he knew when to add and subtract, and which numbers to use, it emerged that he believed that the sums were presented in a pattern:- addition, subtraction, addition, subtraction and so on.

R. How can you tell if it as an add on or a take away?

D. I think it is a take away because that one is an add on and that one is a take away. *He indicated the previous sums. He seemed to think that there was a pattern in the presentation of the sums; add, subtract, add, subtract.*

He chose the numbers in the text that he considered easier for whatever process he had identified using his own unique method. When he was questioned about the text, it was apparent that David had excellent decoding abilities, but he had failed to understand the gist of any of the problems.

IMPLICATIONS FOR THE MAIN STUDY.

It emerged from this study that the success or failure of the children in solving arithmetical word problems lay with their interpretation of the text in the language domain rather than with their competency in arithmetic in the mathematical domain. The final analysis of the data and a search of the literature indicated that a more pragmatic approach would be to teach the children to interpret texts in the language domain using scaffolding techniques (E.g.Reusser and Stebler 1997, Hegarty et al 1995, Yoshita et al 1997).

Therefore, the purpose of the main study became the scaffolding of the children in the language domain by teaching them how to interpret texts, gradually introducing aspects of mathematics into these texts. It was apparent on reading the transcripts that the approach was too directional in a misplaced attempt to encourage the children to concentrate on the solution of the problems using the mathematical word within the text. However, ultimately the children's different approaches indicated the direction for the Main Study, namely a concern with the interpretation of texts.

Chapter 6.

Learning and Teaching Language.

Introduction.

The correct solution to arithmetical word problems is dependent upon two factors: 1) an ability to interpret the text correctly and 2) an understanding of the relevant arithmetical processes (Reusser and Stebler 1997). However, the research into children's interpretation of arithmetical texts has concentrated on their understanding of the language of mathematics within the texts, or on the structure of the arithmetical word problems, rather than on their interpretation of the language of the texts (Borasi et al 1998, Riley et al 1983). Many unsuccessful problem solvers extract the key mathematical words and numbers in the text in a process described as using the 'syntax of mathematics' (Wyndham and Saljo 1997). The successful problem solvers rely upon their experiences that relate to the text to construct a 'mental model' (Hegarty et al 1995) of the problem, and use this model to form the arithmetical equation for the problem (Wyndham and Saljo 1997 and Reusser and Stebler 1997). All or most problem solvers recognize word problems for what they are because even unsuccessful problem solvers use the mathematical content of the text; therefore they do not mistake them for factual or fictional texts. (Kintsch 1998) Although these unsuccessful problem solvers identify the arithmetical word problem schema, they do not appreciate the extent to which the language of the problem affects the construction of the arithmetical equation. The type of arithmetical word problems usually experienced by pupils in school are constructs of education, and are not typical of the type of problems experienced in real life situations, which are discussed in the chapter on arithmetical word problems (Walkerdine 1988, Nunes 1993 Dowling 1998). The important paths to their solution must be taught because 1) their semantic structure may not readily suggest an arithmetical equation and 2) the impoverished text of the problems which are typically given in schools almost encourage solvers to concentrate on the key mathematical words (Gerofsky 1996). The importance of interpreting the text must be emphasized for the solvers if they are to transfer the written information into an arithmetical equation:

'...word problem solving involves a text understanding phase that yields the kind of mental representation needed by the second phase problem -solving phase to compute an answer. Many texts have a conventional structure that readers know and use to organise their mental representation of the text. Thus stories are organized by the story schema and legal briefs by an argumentation schema. Word problems have their own schema that have to be learned in school, recognized as relevant when the problem is being read, and used as an organizational basis for the text.' (Kintsch 1998)

If the lack of computational abilities are discounted and only the language domain is considered, it can be deduced that the difficulties experienced by many children with arithmetical word problems lies within the language domain. Failures in these problems occur because the problem solvers do not interpret the text of the problem, because either they did not appreciate the need to do so, or they lacked the necessary reading decoding and interpretive skills for the task. Some children could solve the problems accurately if they had better computational skills because they can construct the accurate arithmetical equation for a solution but are let down by their lack of basic arithmetical skills, but some children could not solve the problems because their interpretation of the text is inaccurate. (Reusser and Stebler 1997.)

Language and thought.

Although language development fuses the cognitive abilities of the learners with the cultural context of learning, language is a cultural tool and it is only in society that the need to use it and develop it occurs as we communicate with each other. Nevertheless, language is more than a communicative tool because language and the development of thought are co-dependent and fused together in a

social practice of communication (Vygotsky 1986). Piaget considered thought being in advance of language, that is

'language was unable to convey what was not already established in thought. This would seem to imply that language is, at least slightly, retarded compared with thinking. Unless the lag is very small, this would mean that there would be occasions when the child's language was too underdeveloped to express the greater sophistication of his thinking. Using language to diagnose thought would in these cases give rise to false diagnoses of immature thinking; and there are indeed many demonstrations of 'failure of thinking' which appear to be due primarily to language difficulties. Nor is the interpretation of children's language necessarily unproblematic.' (Meadows 1993).

Language and Grammar.

Children can cope with intricate sentence structures. Native speakers use complex grammar and can interpret the meaning of sentences without difficulty, and simple grammatical sentence structures are accessible to children without prior formal teaching of the concept (Chomsky 1969). Children have no difficulty in parsing simple sentences and understanding how to separate sentences into clusters. E.g.

The little boy was bouncing the red ball.

is interpreted as

The little boy was bouncing the red ball.

and never as

The little boy was bouncing

with 'the red ball' becoming redundant.

This ability has little to do with taught parsing, but comes from a functional understanding of the use of language that gives the

readers access to all texts that follow the parsing principles (Lindfors 1991).

'The sentences in a text should be such that the parsing principles are not violated. The parsing principles define constraints for the comprehensibility of texts. If the parsing principles can be applied, the memory load is reduced. If the structure of the sentence is such that it corresponds to the strategy, the reader can interpret.' (Noordman et al 1994)

Although schools 'teach' language, children have already learned it, so schools are refining and defining the rules for the use of grammar rather than introducing it.

'... they did not put these relational understandings in our heads in the first place. We built those understandings for ourselves as we interacted with others as children and in those interactions figured out how language works.' (Lindfors 1991)

In spite of this ability with grammatical structures and parsing, children experience difficulties interpreting written texts. Some texts are ambiguous and even an experienced and skilled reader would be confused about their meaning without referring to a wider context to make sense of them. For instance in this sentence

'John's little sister kicked him in the shins.' (Lindfors 1991)

the emphasis could be either on identifying the little sister as the aggressor, or John's shins may be in the process of being identified as the injured part of his body, or the method of inflicting the injury may be what is of interest. If such a sentence stood alone, then it would be open to several interpretations.

'in summary, then, an item might be ambiguous because one word or phrase in the expression can have several different meanings

1. the sentence can reflect several different relations of the parts, or
2. there are two different possible original meaning sources for part of the sentence, and it is not clear which one the sentence part is a reduced version of.' (Lindfors 1991)

Therefore, some difficulties in interpreting texts may be because of the inadequate structure of the text that fails to make the meaning explicit to the reader, although, if the texts were spoken, the emphasis placed on certain words by the speaker would make the meaning clear. Learners must make the connection between the spoken and the written word by appreciating not only that the written word is the spoken word in print, but also that the printed word does not offer the same degree of interaction as the spoken word, though the reader must interact with the text to interpret it. When ambiguous sentences appear in the written text, a skilled or experienced reader may deduce their meaning from the rest of the text. This is a skill to be learnt because it relies on the reader making connections between all the information in the text rather than relying upon the aural clues in spoken language.

'Becoming a reader requires shifting from the language strategies used to interpret face-to-face oral interactions to the language strategies used to interpret decontextualised essayist literacy.'
(Schieffelin 1986)

Both factual and fictional texts take the place of the spoken word. They impart information and invite the reader to share the knowledge or perspectives of the writers.

'The text is the linguistic form of social interaction.'

(Maybin ed.1994),

and as an important cultural tool, must be introduced to children. However, reading is not an innate skill or one that can be acquired very easily without some specific teaching. In our culture, this usually takes place within the school environment. Before they come to school, many children have experienced the pleasure of sharing books with adults, often a parent, but the story reading methods of doing so are very different from that employed by most teachers. The priority of the teacher is that the learners learn to read the book using decoding methods rather than interpretative skills, and move on to the next book in the reading scheme. When children read at home, they lead the reading, pondering repeatedly over parts that are of interest to them (Martin and Leather 1994). In school, children learn that they do not have the same goals as teachers when they read text. Children read the text to enjoy the story, but teachers frequently use text to teach language skills or reading skills (Mercer 1988 and Martin and Leather 1994). One method of teaching reading to young children is through a combination of the Look and Say method and learning the 'sounds', that is the various phonics of the language. In the very early stages of reading that occur in the first few weeks of their entrance into primary school, they are introduced to the words in their school reading text books, which are illustrated by pictures. Therefore the words

a lorry

are beside the picture of a lorry and the children learn to read these words in the school reading text book and in various other places, such as on wall charts, picture friezes and labels on pictures. Gradually the children are introduced to phonics, at the same time continuing the Look and Say method of reading. Eventually, sometimes over the period of several years, they become skilled decoders, but they must also remember words or every word would have to be decoded. That is, for speed and

accuracy of reading, successful readers must use a combination of memory and very quick decoding skills to be a fluent reader. This fluency of reading assists in the interpretation of text. Children who are poor decoders are also poor at comprehension because they spend so much time trying to decode each word that either they have forgotten the start of the sentence by the time they reach the end, or they exert so much effort on each word that they lose the whole meaning of the sentence. Successful reading for meaning is an interactive process of good decoding and comprehension skills. Unfortunately, the learner readers have to concentrate on their decoding skills and can easily forget to concentrate on the meaning of the text in their effort to read individual words. As the learners become competent in decoding, they can concentrate on comprehension processes and read for meaning and knowledge. The novice reader is learning to read, but the experienced reader is reading to learn and is more interested in the whole text rather than decoding individual words (Maria 1990). Good decoding skills produce fluency in reading; however, reading is a complex skill that requires more than simply decoding skills (Owen and Pumphrey 1995), which are themselves not sufficient for good reading. As Kintsch (1998) said,

‘What makes for a good reader?

The answer to that question is surprisingly complicated. Reading is a complex activity, with several factors that can compensate for one another to a considerable extent. Thus, many highly intelligent persons and fluent readers may be poor decoders, and a person who knows a great deal about a particular domain but has low reading skills can outperform a highly skilled reader under the right set of circumstances.’ (Kintsch 1998).

A good decoder merely reads words accurately, but a good reader comprehends the text by interacting with it. This comprehension of a text always involves a deduction of the meaning based on

experiences, but as each person's experience is unique, comprehension is unique. This perception of the learner as a unique individual within society is not at odds with the constructivist theory of learning. It is necessary to acknowledge that we are all individual with our own personality. We all belong to different subsections within the same society, which affect, influence and helps us to develop as members of society. For instance, children who attend the same school may have a slightly different perception of schooling depending upon their social class, ethnicity, or family background, but they all belong to the same social structure within school. The social constructivist theories of learning suggest that learning occurs within society. The child is not an individual learner, but one who participates in society and learners from communication with others (Vygotsky 1978). Society cannot be considered without issues such as gender and social class that affect learning and create an identity for each of us within our society, so although we learn within social environments, we experience these environments differently and that is what makes us individuals (Rogoff 1990, Sharron and Coulter 1994, McLaren 1995 and Howe 1997). These inequalities, which are part of us, influence our lives to such an extent that it may be impossible to have research that is value free (Bonnet 1994). However, this should not deter the pursuit of knowledge, but be a reminder that these factors exist. Within a culture, we all belong to the same society of that culture, but each social group whether it is family, sport, academic community, religious, or interest group also creates its own little society; so we belong to different social groupings and these offer us varying experiences which affect us. This means that each reader will have a different understanding of the text because of their own experiences that have contributed towards the various concepts associated with the text, such as the meaning of the individual words and the subject matter of the text. Although individuals think they understand each other, their experience will always dictate a slightly different interpretation of the text. (Maria 1990) At the same time, within an overall culture, we have a sufficient number of shared experiences to understand each other.

'Our culturally adapted way of life depends upon shared meanings and shared concepts and depends as well upon shared modes of discourse for negotiating differences in meaning and interpretation.' (Bruner 1990).

In a well-written text that reflects the type of occurrences most of us experience within our culture, we have enough overlap to allow for communication and comprehension (Maria 1990). This permits comprehension skills to be taught to children, even though it may be difficult to do so because of the different inferences placed on the meaning of the text by teachers and learners. In order to be good comprehenders, readers must be able to link up what is explicitly stated in the text and their own general knowledge or experiences. Some children may not realise that it is permissible to go beyond the text and search for the literal meaning within their existing knowledge (Oakhill and Yuill 1998). While others know that they should make inferences, they may have difficulty in recalling or recognizing their own relevant knowledge and integrating it with what is in the text. Martin and Leather (1994) report that children in a year six class who were given the first paragraphs of some novels and were asked to write down anything that came into their heads while reading these paragraphs wrote very little, and one child wrote comments about lunch, classroom activities and not wanting to go swimming.

Kintsch (1998) claims that readers know that texts are organized in certain ways. Narratives in our culture have a basic exposition-complication-resolution structure and Kintsch (1998) says that his research has demonstrated that even four year olds use this schematic knowledge in story understanding. If the narrative is constructed according to some other cultural schema, comprehension is distorted. This knowledge about the different texts is not sufficient for interpretation because Murphy et al (1995) suggest that

'...children need to bring experience of language, life and culture as well as a familiarity with stories and books to enable them to predict a text.' (Murphy et al 1995)

Children need to understand the structure of texts and recognize the various formats, such as the story format that has characters and motives associated with it, or the arithmetical word problem format with necessary information for the solution of the problems, if they are to take out all the available and relevant information for their task. (Kintsch 1998) Nevertheless, Gerofsky (1996) criticizes the linguistic content of these problems and states that there are only three parts in a typical word problem:

- 1) The characters are introduced.
- 2) The necessary information to solve the problem.
- 3) The question.

This format, according to Gerofsky (1996) indicates that arithmetical word problems are based on arithmetical structure rather than on a story-telling format and actively encourage the solvers to ignore the text when they are writing the arithmetical equation. There is evidence, though, in the literature that successful solvers use the text to solve the problem, no matter how impoverished linguistically, so one solution is to give problems which intrigue the children and which have a more interesting text (Askew 1998).

In everyday activities, people recognize and respond to behaviour that is inconsistent for the context. A visitor to a zoo who was watching koala bears and knew how they lived, would respond to a koala bear sleeping on the ground by making up a story to explain its deviation from normal koala bear activity. However, readers often fail to notice such inconsistencies in printed texts because they fail to monitor their own understanding of the text in the same ways as they monitor the illogical occurrences in life.

Readers need to monitor their own comprehension using metacognitive skills. There are two important aspects of metacognition which are directly related to interpretation of texts:

- **knowledge of reading comprehension processes**
- **knowledge of whether one has understood the text.**

Nevertheless, poor comprehenders may not understand that they do not understand the text. Good comprehenders can use their own words to discuss the text, while poor comprehenders do not have sufficient understanding of the gist of the story, so they are reduced to using the words of the text to express their understanding of it. Some children may have good text comprehension but do not understand that they are expected to use their own words to discuss it. Poor comprehenders are not good at picking out the main points in a story and fail to notice inconsistencies in the text. While it may be reasonable for children to assume that texts given to them are logical, they must be able to recognize the illogical because texts with logical inconsistencies provide one good way of comprehension monitoring e.g.

'Koalas will only sleep high up in the tops of trees.

They sleep in the ground on the soft cool grass.'

(Ruffman 1996)

Just as the keen observers in the zoo would notice the discrepancy between the description and reality of the animal's behaviour, so the good comprehenders should recognize the inconsistency in the text. Unfortunately, many children, and adults, fail to notice such inconsistencies in the text because reading is an interaction with the text and readers guess ahead to what is going to happen next, (Martin and Leather 1994) but fail to notice when their predictions are inaccurate. However, when the reader is monitoring their own responses for accuracy, they must be aware of when they

have found evidence for their responses in the text and when they guessed at the answer.

'A child who monitors her comprehension must be able to distinguish between when she guessed the meaning of a text (because it is unclear), and when she truly knows the meaning (because it is clear.)' (Ruffman 1996)

Many of the 'reading schemes' used by schools have developed beyond the production of reading books and use accompanying language exercises to offer the opportunity to learn and practice various linguistic rules in conjunction with the language of the reading books. Therefore, these schemes are more fittingly called reading/language schemes rather than simply reading books. Sometimes the reading/language schemes used in schools encourage the children either to put the text into their own words or to use their imagination when writing about some aspect of the story they have just read. However many of the exercises in such schemes are of the question and answer type which encourage the young reader to use the words of the text to answer the questions on the story. Frequently it would be difficult for experienced adult readers to put the answer in their own words because the questions are so directly related to the text. Moreover, Ehrlich (1996) offers an alternative approach to Ruffman (1996) when she states that the best way to check for comprehension of the text is to ask the subjects of the assessment to think aloud while reading the text and it is by this commenting on the readers' views on the text immediately that the teacher scaffolds the children in their comprehension.

'By producing an accurate instruction suited to the specific cognitive needs of every single reader, trainers provide a first kind of scaffolding.' (Ehrlich 1996)

Text comprehension should be elicited just after a section of text has been read rather than after the whole text has been read and is then 'off line'. (Ehrlich 1996) Although experienced teachers may use this approach, many of the reading/language schemes used in schools continue to produce 'comprehension' type exercises to be done by the children after the whole text has been read. This however is not really reading the text; rather it is more an exercise in matching the content of the questions with the content of the text by using key words within the question to find the answer in the text.

'However, traditionally, we have focused on the text in classrooms and used it as a comprehension exercise to extract its 'meaning'. We are arguing that such an approach only represents half of reading and that there is a need to redress the balance.'
(Martin and Leather 1994).

This is a further reason why children do not always look for meaning in arithmetic texts because these comprehension questions encourage 'phrase spotting' in a similar way to the word problems encouraging the use of key arithmetical words. The following extracts are from level six of Reading 360, a reading/language published by Ginn (1994) and this level is frequently used by children either in the later stage of primary two or in primary three, that is children of seven to eight years of age. They illustrate the point that many exercises do not encourage children to go beyond the printed words of the text when they answer the questions.

'No problem at all.'

Adam had a bad habit. It was a big problem. He liked to call people names. (extract from p24)

Elly Jenkins said, 'He calls me Jelly Enkins. Adam is a pain.'(extract from p25)

(Ginn 1995)

The exercise in the Reading skills book for this particular story is of the question and answer type:

'Answer in sentences.

1. What was Adams' bad habit? (page 24)
 2. What did Adam call Elly Jenkins? (page 25)
- (Ginn 1995)

This type of exercise encourages the children to refer to particular parts of the texts and use key words in the questions to find answers in the texts rather than consider the content of the texts in relation to their own experiences. The texts are usually non-ambiguous and their content limits the type of happenings which could be recalled from past experiences of the readers. Therefore, the readers learn that it is possible, perhaps preferable, to answer questions on the text by using key words in the text.

'The comprehension of oral and textual language presupposes the reader's ability to construct a possible world of intentions, actions and motivations, on the basis of particular linguistic, in this case textual, information. In an interactive model of text processing, readers use background knowledge and contextual information to posit those world structures expressed or implied in a text. The details of these possible world structures, and how they might be different from those readily accessible in semantic memory, however, depend on how the text structures and projects these worlds.' (Luke 1988)

Bruner believes that all good stories must be open to several interpretations, (Bruner 1989) and these would encourage diversity in the discussion of the texts in schools:

'To make a good story, it would seem, you must make it somewhat uncertain, somehow open to

variant readings, rather subject to the vagaries of intentional states, undetermined.' (Bruner 1989).

Unfortunately, many of the books which are given to children in school have the specific purpose of aiding the learning of reading skills so the familiar flow of the text and the cultural story pattern is lost at the expense of readability scales used by publishers (Unsworth 1993). Unsworth considered that

'such scales fail to consider the background knowledge of the reader, contexts and purposes of the reading event, the relevance of the semantic and ideological content, and the text structure as important variables in whether a text is comprehensible to students.' (Unsworth 1993).

Conclusion

The texts and questions that children encounter in reading comprehension exercises encourages an approach to text that interferes with the ability to solve arithmetical word problems by reinforcing the idea that it is more important to identify key words and phrases than to comprehend what is happening in the text. The Main Study aimed to address this issue.

Chapter 7.

The Main Study.

There is no doubt that many children have difficulties finding the solutions to written arithmetical word problems (Stern 1993, Hegarty et al 1995, d'Ailley 1997, Greer 1997, Gravemeijer 1997, Reusser and Stebler 1997, Yoshida et al 1997, Wyndham and Saljo 1997) These problems claim to articulate the importance of mathematics by their reference to real world situations, although the authenticity of this is debatable (Walkerdine 1988, Gerofsky 1996, Dowling 1998). It is said that many children who have the necessary computational skills and sufficient reading ability still do not reach the correct solution because they make various mistakes such as:

- failing to recognise the arithmetical process underpinning the problem,
- using just what they think are key mathematical words such as more and less to reach a solution or
- ignoring the sense of the problem (Gravemeijer 1997 and Hegarty et al 1995).

The fact that the children participating in the Initial Study had a shared history of learning and curriculum, but applied different use of that learning made it apparent that it was important to consider how children develop their thinking in mathematics and language and their thoughts as individuals within society. Therefore various learning theories dealing with how children learn mathematics and language were examined after the Initial Study and, although it is not possible to consider all theories, some have been discussed in the relevant chapters on mathematics and language learning. Those that were selected for investigation, namely constructivist theories, were compatible with the use of scaffolding. Even this limiting of the discussion of learning theories to constructivist theories, does not allow a scrutiny of every type of constructivists theory within this thesis. Nevertheless, this research was informed by the theories of Piaget and Vygotsky, both discussed in greater

detail in Chapter 3. Piagetian and Vygotskian theories are competing but compatible. Piaget stressed that learning occurred individually: individuals are programmed to learn and make sense of experiences and meanings. Vygotsky's learner experienced life and internalized experiences: the learner is encultured by being drawn into cultural practices. Emerging and developing from these theories, the constructivists' theories of learning emphasize each individual assimilating knowledge, but adapting and modifying that knowledge as her or his experiences of the world develops.

During the Initial study, it became apparent that the children who understood the text of the problem were the ones who had the higher success rate (Decorte and Verschaffel 1991). The children who were considered to be successful were those who read and sometimes reread the problems, occasionally commenting on, or asking questions about what was written, and who then formulated the correct arithmetical equation for the solution. Some of them did not solve the problems accurately because they were hindered by their lack of computational skills, but they understood how to do them. It is evident from the comments of the successful problem solvers that they had engaged with the texts of the problems. They remarked on the activities allotted to some of their classmates in the texts of the problems and commented on the suitability of the chores in the text for the children mentioned, and on the reaction of those children if they had really been asked to perform the activities. They criticized the lack of authenticity of the texts as some tasks related in these texts had been allotted to younger children because, in practice, the oldest children in the school would have carried these out. Although the children in this Initial Study had individual computational strategies, a common factor was their interaction with every aspect of the written text, not just the mathematical key words. They envisaged the setting of the problems and reached a solution through their contemplation of the activities of the participants in the problems.

The Initial Study has been described in Chapter 5, but the specific findings of this study, which informed the development of the Main Study, can be summarised as follows. Those who were unsuccessful used the numbers in the text with little or no consideration for their relevance to the question. They scanned the text looking for the numbers and had minimum reaction to the inclusion of their friends in the questions. Their arithmetic was frequently very accurate, but they could not have reached a correct answer to the problems, as their arithmetical equations were inappropriate because they had not interpreted the meaning of the text of the problems. None of them considered the meaning of the text, preferring to isolate the mathematical key words from the 'stories' of the problems in their enthusiasm to form an arithmetical equation. The children's various approaches towards the problems in the Initial study called attention to

- a) the differences in outlook of the teacher/ researcher and some of the children and
- b) the differences in outlook among the children in relation to these problems.

All the children had experienced the same language and mathematics curricula, but they had either utilized their learning from both domains in different ways, or had a different understanding of the use of the learning in both domains in the context of arithmetical word problems. These problems are frequently presented at the end of a period of teaching a specific arithmetical skill; therefore it was assumed during the Initial Study that assistance to solve them would be required within the mathematical domain. Indeed, one major criticism of the Initial Study is that the approach was too directive towards the solution of the problem through an understanding of the mathematical words. It was only on examination of the transcripts of the tapes, the children's work and consideration of the notes made about the children during the study that it became apparent that too much emphasis had been laid on the formation of an accurate arithmetical equation for the solution of the problem. This approach had called attention to the mathematical key words and the

numbers within the problems. However, in this approach, those children who failed to interpret the text of the problems with sufficient accuracy to form the necessary arithmetical equation were encouraged to focus on the key words, a method identified by research as one which often results in inaccuracies (Hegarty et al 1995). The successful problems solvers confirmed that this emphasis on the mathematical domain was too restrictive and that a future study would have to be more concerned with an analysis of the children's answers rather than directing them towards the correct solution. This softer approach would have been more revealing and may have permitted an on-going assessment of progress, an exposition of the children's difficulties and the opportunity to address them as they occurred.

Texts

If the learner is to assimilate knowledge, there must be a match between the new knowledge and what is already known (Kintsch 1998). Children love stories and have experienced them in many forms by the time they have left the Infant stage of school. Therefore it seemed logical to utilize this knowledge of stories as the match between what was already known and what was to be learned, namely how to interpret the texts of arithmetical word problems. Story telling is an ancient cultural practice and is used both to convey a message and to engage children's imagination through words. Arithmetical word problems set the scene in a few short sentences and introduce characters before a question is posed about them. However, there is evidence both in research (Hegarty et al 1995 and Gerofsky 1996) and in the practise of the children who took part in the Initial Study, that the less successful solvers largely ignore the meaning and content of the text of these problems. They prefer to scan the text for key mathematical words and use them to form an arithmetical equation that they hope will solve the problem. Gerofsky (1996) considers the texts of these problems to be so deficient that they almost encourage the solvers to ignore it while Dowling (1998) considers such texts to be neither

mathematics nor to reflect real life. Therefore, for the Main Study, it was planned to have an intervening step of interpreting the text of short stories in the language domain, then using that knowledge to move over to the mathematical domain. The children would be encouraged to observe the characters in a fantasy world, but the world of mathematics would be introduced into that fantasy world. The fantasy world would be conscripted as a vehicle for teaching mathematics much as in the ancient cultural practice of using stories to teach and inform. The introduction of mathematical words within the stories would assist this crossing of the domains because the children would become familiar with them and have the opportunity to discuss their meaning in the language domain before using them in the mathematical domain. It was hoped that this would prevent confusion over the interpretation of mathematical words such as 'more' and 'less' within certain semantic structures because the children would be given the opportunity to discuss text with these words in them. For example,

1. Pete Parrot has 5 seeds. That is 6 less than Joe Budgie. How many seeds has Joe Budgie?
2. Jack, the Yorkshire terrier, has 8 biscuits for breakfast. Jill, the St Bernard has 16 more than Jack. How many does Jill have for breakfast?

During the Main study, some children found the semantic structure of questions of this type difficult because they were unsure of who had more or less. Dramatizing the question with children taking the part of the various characters in the stories helped them to organize the use of these words in their minds because some of these children were observed organizing counting materials into bundles for each character in the text during the sessions when arithmetical word problems were given at the end of the story and during the post-test.

Although assimilation of knowledge is a personal activity, it occurs within a social setting. In his discussion of constructivist theories, Confrey (2000) stated:

'Although the theory stresses the need for each person to form their own understanding of a concept, it recognizes that this process is embedded in and aided by social and cultural relations. Tasks and problematics are mediated by cultural distinctions and defined through social interactions, both peer-to-peer and teacher-student.' (Confrey, p17).

Encouraging the children to discuss written text within the Main Study fitted in with this theory of the social aspect of learning. Many of the exercises experienced by the children in their school language and reading are questions that simply point to the text for the answer. Other exercises may encourage discussion of the text, but very few encourage the child to go beyond the text and predict or relate the story to their own experiences. There is rarely the opportunity for imaginative speculation when there will be no correct answer until more of the story is revealed. If all the answers are available in the text, children do not need to pay attention and think about the meaning of the story to give the correct answer; they simply have to scan the text. When they have to discuss the text or speculate on information that is not available to them, they have to ponder the meaning of the words they are reading. However, they will not all have the same experiences, so their interpretation of the text and their reflections will enrich and develop the ideas of others (Maria 1990, Martin and Leather 1994, Oakhill and Yuill 1996).

Scaffolding.

A fundamental purpose of the Initial Study had been to consider how scaffolding techniques could be used to assist the children

with arithmetical word problems. Before the Initial study it had seemed that scaffolding would be beneficial when teaching arithmetical processes and the language of mathematics. However, the study and subsequent reading of the literature (Stern 1993, Hegarty et al 1995, Wyndhamn and Saljo 1997, Askew 1998) suggested that many of the difficulties that are experienced by children occur with their lack of interpretation of the text of the problems even before they reach the mathematical processes within the problem. Therefore the study developed from being one which sought to identify the difficulties encountered by children within the mathematical sphere of these problems - possibly with arithmetical processes and with the language of mathematics - to discover if teaching children to interpret texts in the language domain using scaffolding techniques would help them to solve arithmetical word problems in the mathematical domain. Although some aspects of numeracy confused a few children during the Initial Study, there was not enough time to incorporate the teaching of numeracy strategies into the Main Study. Therefore, for the purposes of this study, it was intended to consider the correct arithmetical equations for the solution of the problems as an accurate solution.

Scaffolding, which has been discussed in more detail in Chapter 4, demands that the more competent member of the dyad perform the part of the activity beyond the scope of the learner, but relinquishes the task to the learner gradually as the learner gains competency until all help has faded and the learner performs the task alone (Bruner 1985, Greenfield 1984, Tharp and Gallimore 1988). The degree of interaction which is possible within a social dyad is difficult, if not impossible, to maintain within the classroom situation (Bliss et al 1996). Nevertheless, scaffolding remains an appealing idea as it suggests that it is possible to encourage the school children to take charge of their own learning in that

- they themselves control the pace of that learning,
- they control the extent and amount of help given to them and

- there is fading of that help by the teacher as the children become competent.

This is not to say that scaffolding is a wholly child centred approach to learning because the tutor is the person who dictates what is to be learned (Renshaw 1998). It is child centred in that the teacher must be sensitive and responsive to the learner, and the learner must be willing and an active participant in that learning process or learning does not occur. Learners are enlisted to become active participants in the learning tasks by being aware of the end goals of each task (Wood et al 1976). This awareness of the end goals of the tasks permits the learners to fit their knowledge to the requirements of the new goals of each task. Thus they can accept or seek help when their lack of knowledge of the new task makes this necessary, but work alone as soon as they have sufficient knowledge or skill to do this. Both tutor and learner are actively involved in this negotiating process through their verbal and visual interactions with one another and by continuous assessment of the learner's work by the tutor. If the specific attributes of the interactions of the tutor and learner in the scaffolding metaphor are not adhered to, then the interchange can no longer be described as scaffolding. For instance, if the tutor observes the learner struggling with part of the task, but chooses to permit the learner to discover how to do it, or fails to respond to the needs of the learner, then scaffolding has not taken place. On the other hand, scaffolding can be considered to occur provided the main characteristics of scaffolding are still present (Mehan et al 1996, Tharp and Gallimore 1988). Therefore, in the classroom situation, it may be permissible to interpret the scaffolding metaphor in a way that acknowledges the bond between learner and tutor but accepts that the degree of perception that the tutor has of the learner, and the relationship of tutor and learner within the social dyad cannot be replicated within the classroom situation. Therefore, for the purpose of the main study the basic features of scaffolding were identified as

1. recruitment of the child's interest
2. reduction in degrees of freedom

3. maintaining goal orientation
4. highlighting critical task features
5. controlling frustration by demonstrating idealized solution paths (Wood et al 1976).

It is difficult to transfer scaffolding to schools. Any attempts that are claimed to be successful are sociable, relying upon the other more knowledgeable members of the class or group, as well as the teacher, to scaffold the learner within the Zone of Proximal Development (Mehan 1996, Renshaw 1998). Therefore, during the main study, vibrant and energetic discussions of the texts had to be maintained to encourage all the participants to take part and to retain their interest. Within the classroom and large group situation considerable interaction and discussion about the prepared texts was going to be encouraged, so responsibility for the scaffolding processes could be shared out among adult and peers. This meant that although the adult may, for example, recruit the learners' interests and control frustration by demonstrating idealized solution paths, the more competent peers within the group or class situation might be responsible for the other characteristics of scaffolding. Only the child or children who obviously needed assistance would be given it and only as much as would be required. In some instances, this could mean very specific demonstration of the idealized solution path. In a school situation this may replicate an apprentice-type interaction with the teacher demonstrating an idealized path for more than one pupil, but offering assistance to individuals, if required. The difference between scaffolding and teaching in these circumstances is that in teaching all the children receive the same amount of instruction which may be planned before the lesson begins, but in scaffolding only those needing help are given it and only as much or as little as needed for them to complete the task by themselves (Bliss et al 1994).

Classroom teachers must plan their lessons and have an expected end goal for each lesson. Although scaffolding techniques must be responsive to the needs of the learner, it is at this point that it is

possible to prepare for the contexts where scaffolding is most likely to occur. For this study, these were identified as

- during the reading of the text of the stories,
- when introducing the specifically mathematical words,
- during the introduction of the arithmetical question within the text of the stories and
- the arithmetical question at the end of the story.

Although the nature of scaffolding prevents the planning of a specific strategy, to lessen the loss of scaffolding opportunities, certain tactics were planned before hand. The transcripts of the sessions were later analyzed for the frequency of scaffolding during the sessions and are recorded in Appendix 1. For the purpose of the analysis, the segmenting of the text and the reminder of the end goal of the task were not computed as this was done in every story, but the following strategies were considered for analysis:

- Reminding children of critical features of the task and scrutinizing the task (either for the pupils or asking them to do it).
- Breaking the text up into short manageable segments for discussion and checking that the children understand each small segment of text.
- Encouraging the children to connect the texts to their own experiences.
- Encouraging other children to explain the meaning of the text in their own words and guiding towards a shared understanding of meaning of the texts.
- Ascertaining that the children know what information is necessary for the formation of an arithmetical equation.
- Checking that the children know what type of arithmetical process should be used.
- Keeping the children on task.
- Holding information for children who may be occupied with another aspect of the task.

- Guiding children to necessary part of text and focusing the children on specific strategies, i.e. using the text to formulate an accurate arithmetical problem.
- Check that children know how to solve the arithmetical word problem, perhaps by demonstrating the idealized path.
- Teach what the children do not know. (Basic arithmetical facts and skills had to be excluded because of lack of time, but the children were allowed to use concrete materials e.g. Unifix bricks.
- Check that each section of text relates to another. (In some of the stories the information provided in one story was a necessary clue for a missing fact in another story).

THE RESEARCH METHODS.

The Initial Study took place during the month of December 1997. The intervening period between December and Spring 1999 was occupied with literature research and preparation of the materials for the Main Study. Discussions took place with the head teacher and the teachers of the classes of the participating children about the criteria for the study. The teachers were not asked to identify suitable candidates for the study at that stage because a) school rolls fluctuate and b) children develop. The language and mathematics textbooks, curricula guidelines and National Test Results were examined to allow for the preparation of appropriate materials that would be used for the study and for pre- and post-testing.

The Main Study took place in one of the largest primary schools in the West End of Glasgow throughout April, May, June, August, September and October before and after the summer holidays of 1999 and was a direct development of the Initial Study. The school has a wide catchment area that includes privately owned houses and a large council housing estate. When the education and financial status of the parents are considered, the children have

diverse backgrounds, but the school roll of over three hundred pupils has fewer than five children from ethnic minorities of either an Asian or Caribbean background. Many of the children are of Irish ancestry although most of them have now little connection with Ireland, as it was the grandparents or great-grandparents who came to work probably in the nearby Clyde docks or in the factories of Clydebank and the local whisky distilleries or as labourers in the post-war building boom. In April, May and June the participants were three groups of eight children from primaries three, four and six.¹ As the study before the summer holidays progressed, some of the children went for an early holiday or were absent for several of the teaching sessions; so six children were counted in the final analysis of each group. These groups experienced considerable success with the prepared materials and scaffolding techniques, so in August² the study was extended to a primary six class to discover if the materials and teaching methods would be applicable to a whole class situation. The children had just returned to school, so they were effectively still a primary five class because they were revising the work they had experienced just before the holiday rather than embarking on primary six work. This meant that the study was conducted with pupils from various stages of the primary school outwith the infants, and in a class as well as in groups. It covered the age ranges of seven years and three months to ten years and six months. It had been inappropriate to invite the primary seven classes to join the study during the 1998-1999 session because of various activities throughout the year and their work commitment in preparation for the secondary school. Some of the primary seven class of August 1999 had already taken part in the study as primary six pupils and the teachers were anxious to spend a considerable time revising the primary six work.

¹ The ages of the children were as follows:

P3: seven years and two months to eight years and two months

P4: eight years and two months to nine years and two months

P6: ten years and two months to eleven years and two months.

² Schools in Scotland start their summer holiday at the end of June and their autumn term in August.

The school has two classes at every stage, so the pre-summer holidays groups comprised of children from both classes at primary three, four and six. The teachers were asked to identify eight children in their classes who had not been involved in the Initial study, who were competent readers and who were sufficiently numerate to have reasonable success with their class work. The children, particularly those from the primary six classes were those who were having some difficulty with mathematics within their classroom, although none of the children in the study found mathematics an easily understood subject. These children were pre-tested in April with the permission of their parents. The pre-test consisted of the compare, contrast and combine arithmetical word problems described by Riley et al (1983) as compare 6, combine 2 and change 5. (See page 14.) They were chosen because the literature suggested these were the problems that children found the most difficult of the compare, combine and change type because the semantic structure of the question made mapping the problem with an arithmetical process difficult for some children (DeCorte and Verschaffel 1991, Stern 1993, Hegarty et al 1995). The following are simple examples of these types of problems:

Type: Compare 6.

Nicola has 3 apples; she has 5 apples less than Colette. How many apples does Colette have?

The direction is less and there is an unknown reference set.

Type: Combine 2.

Nicola and Colette have 8 apples altogether. Nicola has 3 apples. How many apples does Colette have?

There is no direction and the unknown is the subset.

Type: Change 5.

Nicola had some apples, and then Colette gave her 5 more apples. Now Nicola has 8 apples. How many apples did Colette have in the beginning?

The direction is increase and the unknown is the start set.

These types of problems were used for the whole of the study although the numbers included in them matched the experience and work of the classes. Therefore, although the primary three group were not expected to produce answers greater than fifty, the primary four group had numbers in the hundreds, the primary six group were working with thousands because they had completed their primary six work, and the whole of the primary six class with hundreds because they were revising primary five work. This approach permitted the semantic structure of the questions to be the same for all the children. The results of the pre-test were collated (Appendix no. 2) and the participants were matched with controls at each stage. As far as possible there was an equal number of boys and girls in the groups of at least six children and a combination of children who had every answer correct, none correct or either one or more compare, contrast or combine sums wrong. The primary six class had to be kept together as a group even though some of the children required learning support for reading or mathematics. Those who required very specific help were given it as needed during the study, but were not included in the final analysis. However, there were eighteen children out of a roll of twenty-four who were suitable candidates in that they were able to read the text, had knowledge of the arithmetical processes and were rarely absent. Therefore eighteen children within the groups and eighteen children in the class were the final subjects of the research although more children, but of a variable daily number, took part in the research. These children were those who had been approached initially but discounted because of family holidays who chose to join the groups when they were in school.

Many of the children in the class and groups recognized the difficulties they were having with arithmetical word problems in the pre-test and even some of those who had accurate answers lacked confidence. At the end of the pre-test, the children were asked to put a face with a smiling mouth beside the problems they

found easy, a face with a straight line for a mouth at the problems they found a little difficult and a sad face beside the problems they found very difficult or could not attempt. Some children who had correct answers indicated that they found the problem difficult with the use of the face symbols. There were some who had wrong answers, but considered the sums to be easy because they had totally failed to understand the question and had opted for simple addition of all the numbers or subtraction of two of the numbers.

The purpose of working with the groups was to discover if helping children to interpret text in the literature domain by using scaffolding techniques would assist them to interpret the text of arithmetical word problems in the mathematical domain. When the groups for the study were organized, the children were brought along on a daily basis as far as was possible with the timetable of the school. That is, the primary three group came daily until all the stories prepared for them had been read. The primary four group followed them, then the primary six groups in the following days. Therefore, only one group came at a time until they worked through all the materials. This was to inflict as little disruption as possible on the school. However, there were interruptions for weekends, public holidays, outings and various class activities so although there were six stories prepared for each group, there was always at least one weekend between two stories for each group. During one session, the primary three group had been given short arithmetical word problems and had been encouraged to embellish the short text and extend it into a story before solving the problem. This was to link the longer texts of the stories with the short text of the arithmetical word problem. There was not enough time allocated to the study to offer this experience to the other groups or to the class although it was a helpful practice. All the children in the learning groups, the control groups and the class were post tested. They were given six arithmetical word problems, two each of change 5, combine 2 and compare 6 in a random order. The post-tests took place at the end of June, just before the summer holidays. All the children who had been pre-tested were post-

tested. The results are in Appendix 2 All the sessions were tape-recorded and any particularly relevant behaviour was noted on paper at the time. The transcripts were typed and the following initials were used:

R: researcher.

Gr. if several children in the group answered at the same time or gave the same or similar answers.

Names: The pseudonyms of individual children.

Cl. Discussion within the class.

? : Either the name or voice of the child responding was not recognizable on the tape recording of the sessions. It was more important to keep the session flowing and interactive rather than identify a child who had called out a response.

Most of the children had a strong Glasgow accent and used expressions and syntax associated with that city. Sometimes this is apparent in the transcripts, although any 'Broad Glasgow' words were translated into in a more accessible English for a wider audience without losing any of the meaning.

THE STORIES

The stories were the important link between the language and mathematical domain and were used to facilitate the scaffolding process. It was extremely important that the children should interpret the text of the stories accurately. The successful problem solvers in the Initial study always did this and research by DeCorte and Verschaffel (1991) and Hegarty et al (1997) confirmed that a realistic interpretation of the text offered the greater opportunity for success. At the end of the study, the children should have been more aware of the need to interpret the text carefully and accurately and to understand the language of mathematics. Even if the semantic structure of the problem immediately suggested an arithmetical equation, they should know to use the text of the problem to construct the equation rather than rely on the order of

mathematical words within the problem. For instance, in the following example, it is possible to extract the arithmetical equation directly from the text, but this practise was being discouraged.

John had 7 pencils and then his Dad told him to
give his sister 3 of them. How many pencils does
John have now?

Each group had children from both the classes at their year level. It had been anticipated that the children might have been slightly apprehensive about working with a teacher who had never taught them and children other than their familiar classmates, although they did meet up for recreational activities. Therefore, each group had a short introductory session to permit them to be aware of the other participants and to talk about the use of the tape recorder, The format of the sessions and the expected outcome of the sessions, namely the ability to solve arithmetical word problems. The groups were removed from their class for the testing and teaching sessions. These always took place at the end of the day to cause minimum disruption to the children's class work. This was not the time when the children expected to be asked to do arithmetic. Most of the class teachers of the participating children read them a story at the end of the school day, but this custom did not work particularly favourably for the study as one of the goals of the study was to help the children to interpret all aspects of the text of the story, while the class story was more like an early bed time story read purely for the enjoyment of each child when the children could think about parts of the story which interested them alone and not consider the whole text (Maria 1990). At home, many children choose to have the same bedtime story read to them several times in order to assimilate all the information. Unfortunately, during this study they were not given the luxury of re-reading the stories and there was the danger that each child would focus on a facet of the story that she or he found interesting but miss the meaning of the whole text. Therefore, it was important that the stories were not thought of as an easy listening type. For that reason they had to grab and hold the imagination of the

children throughout, but they also had to stimulate discussion while providing the opportunity to scaffold the children in the interpretation of the text. It was important that they be recognizable by the children as stories firmly situated within the language domain and not a written mathematical construct (Gerofsky 1996). As the bond between the domains, the stories were also the vehicle for introducing the language of mathematics into the texts in a way that encouraged the children to use the text to form the necessary arithmetical equation without over-emphasizing the use of the key mathematical words. The stories were intended to amuse the children and utilize their interest in story telling. They were outlandish stories with eccentric characters, bizarre occurrences and ridiculous and exaggerated numbers within the text. There was some continuity in that characters frequently reappeared in stories, but their behaviour or experiences were not intended to permit the children to be complacent or able to assume that they could predict the next step. This was all intentional as it was very necessary to keep the children concentrating on the importance of interpreting the meaning of the whole of the text.

Although it may be impossible to be totally gender unbiased in texts (Pinset 1997), the stories were written to maintain a balance of power between the male and female characters and reflect the various social backgrounds of the pupils in most schools. It is not possible to cater for everyone's taste and interests, but the characters in the stories mirrored the experiences of the children. There were single and divorced parents, unemployed fathers and mothers, children who enjoyed very good holidays and those who managed no more than a day trip to friends, grandparents who did most of the holiday and after school child minding while both parents worked, extended families and some which had both parents in residence. Each story gave some information about the characters, but left certain aspects of them to be deduced from thinking about the text. All the stories contained elements that were either true or debatable. For instance, the ages of the

children in the stories were never given, but the children could guess their approximate age from clues in the story though they could not be certain of the accuracy of their speculation. Other facts were clearly stated and were true, while some more were not stated within the text but could be deduced from the story content. A core of characters remained in all the stories for each of the groups and the class, but the characters were different for each group and for the class, and reflected the age level and interests of the children. Some stories for the groups were more explicitly linked than others through their characterization and, as the children were very interested in following the exploits of the characters from one story to the next, it was decided to adopt this approach for the class rather than have stories that stood independently from one another. The class stories revolved around a family and their many relatives and friends with information about the family gradually being introduced in each consecutive story. As readers frequently can be inaccurate and 'read' what they think is printed (Cornoldi et al 1996), the children had to know that it was possible to check the text for facts and, although sometimes it was permissible to guess or predict, they had to be prepared to alter their opinions if the text eventually gave them evidence that they were incorrect. Frequently there were gaps in the information given about the characters and the children were encouraged to think about how these characters could develop. As each story progressed, it was then possible to refer back to the first impressions of the children and discuss whether or not these should be altered. This was to emphasize that all aspects of the text had to be considered and to counteract the tendency of children to use only the key mathematical words in arithmetical word problems to form the arithmetical equation for the solution of the problem.

Although any appropriate story could have been used for the interpretation of text, these stories were written for the specific function of scaffolding and introducing the language of

mathematics into the texts. This entailed the writing of six stories for each stage, twenty-four stories in all. In every story in the series of six read by each group or class, arithmetical words were incorporated into the stories, for example:

Poppy took some crusts, but she always ate less than Amanda. (Primary 3).

Gradually the format of an arithmetical question appeared informally in the text. Although the children were not required to form an arithmetical equation to solve it, it presented the opportunity to consider the meaning of the text, for example:

'I have sugar lumps to give to him before I go to bed.'

He held out his hand to show them to the leprechaun. The leprechaun took something out of his pocket.

'Take these 5 lumps of sugar,' he said. 'That will make 8 altogether.' (Primary 4).

Eventually, an arithmetical question was given to the children at the end of the story which always made a precise use of the information about the characters that appeared in the stories to enable the children to go back and think about the sequence of events when they were constructing their arithmetical equation. This was to encourage the use of the text rather than the syntax of the problem alone. In the following extract from a Primary Three story, the children are given advice and guided by questions towards the important part of the text before the word question. During the session, the group discussed these questions before they tackled the word problem. This was scaffolding by guiding and limiting their choices (Bliss et al 1994).

"I want to go home now," said Ginger. "I'm tired."

"I am still hungry," said Mrs. Fox. "Let's play a game. Who can find the most sandwich crusts?"

Ginger and Rusty started looking for sandwich crusts. There were lots, as many children in the school did not eat them. They collected lots of crusts and started counting them.

'I'm tired. Want to go home,' said Ginger.

'Keep counting,' said Dad. 'Your Mum is hungry and she has found lots of lovely sausages.'

'We've no more crusts to count,' said Rusty.

Dad dashed away and came back with more crusts.

'That will keep you busy for a few more minutes,' he said.

The fox cubs counted the crusts Dad gave them.

'Thank you for the 16 crusts, Dad,' shouted Rusty. 'We've got 24 crusts now and 12 of them are from crusty bread and the rest are from plain bread.'

'How many did we have before Dad brought us some?' asked Ginger.

'I'm not sure. I'll have to think about that,' said Rusty. He sat down to start counting but he fell asleep and started to dream about a school for foxes where fox cubs ate all night until the sun came up.

'Wake up, you two,' shouted Mum. 'Time to go home.'

Think about the crusts. What are you told about them? How many were there?

How many had the fox cubs collected by themselves?

Arithmetic question.

Dad gave the cubs 16 crusts. The cubs counted and had 24 crusts with 12 crusts from crusty bread and the rest from plain bread. They counted all the crusts. They had 24. How many had the fox cubs collected by themselves?

The problems always contained a number that was not needed for the formation of the arithmetical equation. During the Initial Study, the successful problem solvers who used the text always disregarded this extra number. Without this extra number, it would have been easier for a child to form the necessary arithmetical equation by accident. Although the inclusion does not wholly guarantee the removal of an element of luck, it seemed unlikely that any child could solve all or most of the questions in the post-test with accuracy if they all had an extra number without making use of the meaning of the text. The characteristics of the scaffolding processes were followed. The children's interest was recruited by the stories. The end goal was that they would learn how to be successful in solving arithmetical word problems and in each case that they would solve the particular problem presented. There was a reduction in the degree of freedom because they were kept to the task on hand, that is, interpreting the text accurately. The goal orientation was maintained throughout

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because the goal did not change from interpretative skills and from the stories gradually merging the language of mathematics with the language texts. The critical task features were constantly highlighted because the texts were written to allow for constant discussion. Frustration was controlled because the children were helped as necessary and the other children in the group or class also offered assistance. Reminders about the difference between what the children thought the text said and what it really stated demonstrated idealized solution paths. Sometimes help was given with reading:

Jack. Did that say a Barbie?

R. What?

Jack. John *pointed to the word 'bag'*. I thought I heard Ann saying 'Barbie'.

R. It says a bag full of shells.

At other times the scaffolding had to be more specific and the other children were recruited into the scaffolding process. There was constant feedback from either myself or other children on all aspects of the discussion. Sometimes this took the form of encouraging the child, at other times the children were quite firm in redirecting the other group members. Frequently, either a peer or myself would help one of the children group or class in working out the meaning of the text or with the formation of the arithmetical equation.

EXPERIENCES WITH THE GROUPS.

The scaffolding strategies of highlighting the main feature of the task and breaking the whole task down to a manageable size were employed when each of the sessions started. The children in each group and class were reminded that they had to read the title, they had to think about the meaning of the stories and that we were going to stop frequently, usually after each paragraph, to talk about the part we had read. By considering small chunks of the story and

discussing them, the children who were poor decoders were helped in their interpretation of the text. This was because research states that poor decoders spend so much time decoding that they lose the gist of the meaning of the text (Maria 1990). This also allowed the group to come to a shared understanding of the meaning of the text through discussion. (Martin and Leather 1994) Those with greater understanding helped those children who needed assistance with part of the text until they could grasp the whole meaning.

It was obvious from the outset of the study that the children had become used to their own class teacher's method of interaction during reading because those in the Easter - Summer term had experienced the same teachers for almost a year. The primary six class had the same teacher as they had in primary five and were very familiar with her approach to work. The groups were formed from a total of six classes, so in all there were children in the study who came from seven different teachers, all with their own specific teaching methods. Therefore, some of the children were used to an approach that directed them towards the answers in the text while others were comfortable with discussing the text and sharing their opinions. It had been a matter of some concern that this would result in a combination of non-participant children and talkative children in the same group when there were two teachers of very different approaches in the same year level. However, the children very quickly mingled within the group and communicated very well. The location of the study also assisted the children to relax and talk as a group. The room chosen for the study was the one I used for learning support. It was at the end of a corridor, separated from the rest of the classroom by the medical suite. The room was of the same size as the classrooms, but it was sparsely furnished with brightly coloured tables and was organized to create a calm atmosphere for the children who normally visited it, with flowers, herbs and plants on the tables, some of them being grown by the children who frequented the room. This environment may have contributed towards the ease with which the children settled

within their new groups and tackled the materials of the project; nevertheless, any work done within the room with the groups could have been carried out within a classroom with equal effortlessness. The reason for the groups' withdrawal from class was simply to facilitate the tape recordings and to permit children from two classes to be united, but this would not be of concern to any class teacher using the materials or implementing the scaffolding strategies. The fact that the primary six class stayed within its own familiar classroom and that the children were within their social groups meant that the children spent no time becoming used to one another. Although there were different age groups, the types of interactions and comments were similar from all of them. For instance, in spite of the deliberately exaggerated content of the stories, the children could relate some of the experiences to their real life, possibly because they themselves seemed to be inclined to be excessive in their descriptions.

Just before the post-test, the children were given arithmetical word problems and asked to make up stories to go with them as a final link between the language and mathematical domain. In the Primary Three class the question was:

Jim and Ann were at the seaside with their Mum. They were gathering shells to put in a bag and take home. They brought them over to Mum. Jim said he had counted his shells and he had 36. Ann looked at hers and said she did not have so many. Mum said, 'Never mind, you can keep mine,' and gave Ann 16 shells. Now Ann had 23 shells and Jim had 36. How many shells did Ann have before Mum gave her some?

The children were discussing the possible time of this outing and why the family was there. This was to encourage them to consider arithmetical word problems as something they experience in their own lives. Sara was the first to give her opinion of this particular outing, which sounded reasonable, although her understanding of summer sounded dubious. In an earlier conversation she explained that her Mum liked to go abroad in the summer 'for the sun because there was none here', so this was a case of not fully understanding the adult's use of language and not truly appreciating another person's point of view especially as we were experiencing very warm sunny weather throughout the whole period of the study and her class had been studying time and the seasons as part of a project. Her misunderstanding was diplomatically ignored, so should not be considered a missed opportunity for scaffolding. There were a few times throughout the course of the Study when children exhibited a lack of knowledge or expertise in an area where their peers were well informed and skilled and the decision had to be made to ignore it at that time rather than cause embarrassment to the child. Such information was passed on to the class teacher to be dealt with at a more appropriate moment although it would have seemed to an observer to be a missed opportunity for scaffolding a child.

It takes about one hour to reach the Clyde coast from the school that is situated less than half an hour from Loch Lomond where there are some sandy and pebbly beaches so the reasons for an outing were very inventive.

Sara.. They were at the seaside. It was a Saturday or Sunday and it was a sunny day so they went to the seaside.

Jack Or it could have been a trip from school and they could just lift them up. They could be helping the teachers.

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Don. Or they could be at Sunday school (Church of Scotland) and they could be out with them because when I went to Sunday school we went on trips.

Kate. It could be the summer holidays.

Sara. No because it's not really sunny in the summer holidays.

R. Does it say it is sunny?

Don I think they just took a day off school.

Steve. One day I went to the dentist and my mum just took me and my wee sister to Helensburgh after the dentist and not back to school.

THE GROUP EXPERIENCES.

Primary three.

The group were meeting for the story sessions for the first time. The title of the story, *The Foxes* was read to them and they were immediately encouraged to talk about foxes. This was to make a connection between knowledge they already had and any new information that may be given to them in the story. Although the story was fictional and had talking foxes, there was a link with reality because the foxes lived in a den, scavenged for food and were wary of humans. Therefore the story itself provided a link between the real world and the fictional world. However, it is important that the children should appreciate that it is not acceptable to interpret text in a fictional manner by guessing facts that are not given to them within the story and stating that they are true. The role of creating fiction belongs to the writer of the story, not to the reader. Throughout the discussion, they were scaffolded by those strategies already identified on page 13:

The Foxes.

R. This story is called *The foxes*. Who knows anything about foxes?

Gr. Long tail. Wild animals. Back garden. Nocturnal. Hunts.

The group were fairly knowledgeable, perhaps because foxes are frequently spotted in the gardens where they live. They made the leap from the real world of knowledge about the habitat and habits of foxes to the fantasy world of 'Mr Fox' with little apparent difficulty, but they were not elaborating very much on their answers. They could explain facts about the foxes, but they were hesitant when they started to discuss the more imaginative aspect of the story. It may have been helpful if they had been reminded that this was a make belief story, but sometimes children drift in and out of the fantasy world and real world with no difficulty. Such stories are little different from the family stories of their elders as children which most children relish and which demand a great leap of the imagination into a past era.

The group continued taking turns reading the story. They were stopped to make sure that they had understood the meaning of 'Spring'. Although the only information about Spring in the story was that the flowers were starting to grow, the children gave other signs:

R. How did Mr. Fox know it was Spring time?

Gr. Weather, leaves growing on the trees, flowers coming.

Mr Fox smelled the flowers.

R. Have you seen foxes in the park?

Gr. No.

R. Do you think it is possible that they live there?

Gr. Yes.

We discussed the suitability of the park for a nocturnal wild animal that likes to hunt and they agreed that it was a most appropriate living place. For the next part of the text, the children had to speculate and accept that there were no right or wrong answers because we are not given sufficient information and they had to deduce information from what they were told.

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R. He waited all day for everyone to go home. Why was the park so busy?

Jack. It was a sunny day?

R. The children had been playing in the park every day. When can you get out every day to play in the park?

Matt. When it's nice and warm.

The children were intent on using the weather as the sole reason for visiting the park and they had to accept that this was not a realistic explanation.

R. You don't come to school when the weather is good?

Gr. Laughed. Commented on the weather at that time that was very dry and sunny. They agreed that this was not a good enough reason and said that they had to be off school.

R. When are you off school?

Don. You could just stay off. (Giggling.)

Kate. It could be the weekend.

The children had returned to school just over two weeks previously from their Easter holiday. They had to be reminded about this.

R. What holidays do you have in the Spring?

Sara. Easter.

R. That's it! It must have been the Easter holidays, or the weekend. Did you see Mr fox in the park when you were there?

Gr. No.

R. But he was there watching. He said that it was picnic time again. How could he tell?

Liz. It must have been the food they dropped.

Discussion about picnic food.

It was now time to bring the group back to the task of interpreting the text of the story and assess the amount of information the group had taken from the text.

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R. From that little bit there we can tell lots of things about Mr. Fox. What can we tell about him? (Indicated the first paragraph in the story.)

Gr. Spring, likes chocolate, came out at night, Easter holiday, etc.

The group had related all the facts that the text had given them about Mr. Fox and had listened to each other and added to what was already said. The next paragraph introduced the names of the fox cubs, Rusty and Ginger. These were deliberately chosen because they were genderless names and offered the opportunity of discussing facts which were in the text and were indisputable and information hinted at in the text, but with no way of knowing what was the correct answer at that stage of reading. However, the discussion took an unexpected turn and it was one of the girls who delivered a sharp and accurate correction.

Gr. Discussion about names of twin foxes and whether they were boys or girls.

Don. It's obvious that it's two boys.

R. How did you figure that out?

Don. Every story is about boys.

Gr. No it isn't!

Ann, Just because you're a boy doesn't mean everyone in stories is one.

There was no response from Don.

R. Did you hear what Ann said?

Don. Yes.

Ann seemed to be encouraged when Don was silent, so she pursued the subject.

Ann. Was Mrs. Fox a boy?

Don was silent, but Ann and the group were waiting for a response.

R. Was she?

Don. No she isn't.

R. So Ann is quite correct, then? Not everyone in stories is a boy?

Don agreed although he commented that most stories he read were about boys. The group gave him examples of stories that featured boys and girls and he had to reluctantly agree with Ann that most stories were not about boys.

Ann had been encouraged by my demeanour attitude in this discussion to make her point about the stories. I had not interfered, or changed the subject so I had effectively encouraged her and had kept the group on the task of discussing an important aspect of stories. My question, 'So Ann is quite correct, then? Not everyone in stories is a boy?' had forced Don to keep to the task and respond.

Don. Reading....4 crisps in a bag.

R. What do you think about that?

Matt. I don't think crisps are very good for babies but they could have one each. (Baby in family, so she immediately related the story to her experiences and told us what she was and was not allowed to give to the baby who was now several months old.)

R. Would you feel well fed with one crisp?

This was to bring the group back to the goal of interpreting the text of the story.

Gr. No! Followed by description of food consumed for lunch.

Matt. reading.... I found some earlier, so that's nine crisps they've eaten tonight. Time for proper food.

Although the children were not expected to solve the arithmetical word problem at this stage, there was information at different parts of the story which could have made an arithmetical word problem and this was now brought together verbally into a simple problem

format for the children. This was to demonstrate how the information within the text could be used to solve the problem.

R. If he brought in 4 crisps and his wife said they had eaten 9...how many had she found earlier?

Matt She found 5. Several in group agreed that this was the correct answer, but a few looked puzzled.

R. Well done! That was complicated. Mr. Fox found 4 and the foxes had nine altogether so Mrs. Fox must have found 5 because 4 and 5 makes 9. Used cubes to demonstrate. If cubes had been used when the question was asked, there may have been more response as some children relate to visual cues and need materials or visual aids to help them.

Ann. Reading.... Pizza for me....fish and chips....

Matt. He'll have to go to the chip shop. Laughing and commenting on text, wondering how the fox would order his fish and chips.

Gr. Laughed at thought...talked about it. There was a little bit of acting out the fox ordering the fish and chips and wondering about the reaction of the shop assistants and the customers.

R. Have you ever seen a fox in a chip shop? This was an attempt to bring the group back to what it said in the text. Although the foxes were permitted to speak in the stories, all other attributes of foxes as wild animals were retained.

R. Where is he going to get this fish and chips and pizza?

Ann. On the ground.

Gr. Some people drop them....

Matt. He'll get chips outside the chip shop.

Liz. Cats go to the fish and chip shop.

R. Why?

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Sara For chips! Laughing.

Sara. They smell the fish.

R. What other food would be lovely food for Ginger and Rusty?

Gr. Joking about food, contents of school dinners.

Liz. Reading continued.... lovely night...

R. What makes a 'lovely night'?

Kate. It was nice. This is one of the words the children are discouraged from using in their stories.

R. What makes it a nice night? The children had to expand the meaning rather than repeat the word.

Gr. sunny, dry etc.

Kate. ...Read to the end of the story.

R. What can we tell about the foxes from that story?

Gr. Talked about cubs...happy, twins...wanted to see the fish and chip shop....

R. There are some things we still don't know...are the twins boys or girls?

Gr. All stated that they did not know. The story did not tell them.

R. Sometimes we have to really read the story to think about it. Don thought the twins were boys, but the story does not tell us. There are several sets of twins in the school: two boys, two girls and one girl one boy. The group talked about them and decided that it was not possible to tell which type the foxes were from their names.

R. That's right.

This provided positive feedback on their understanding.

R. Sometimes the story tells us something, but sometimes we guess. When we guess, we do not know if we are right or wrong.

This gave guidance and demonstrated the path for the future.

The other Primary three stories continued with the same type of scaffolding interjections and guidance. Sometimes it was necessary to permit a child to struggle to gain understanding of a small part of the text while maintaining a general understanding of the whole text. Although Don's belief that all stories are about boys was dealt with swiftly by Ann, who was implicitly supported in her reaction by me, and he seemed to concede very rapidly to her, another child, Sara, was so puzzled by part of the text that she could not progress beyond that part without assistance. In this extract, she is having two separate difficulties with the text. An arithmetical word problem was given to the children at the end of this particular story, 'Andrew is going on holiday', using the information given to them in the story. It was quite unexpected and surprising to discover that a child of primary three did not know that a postcard requires a stamp which costs money, especially when there are various activities such as shops and post offices set up for them within a playroom in the school and the postman features in their reading scheme. She had been so totally distracted by the discovery that a stamp costs money that she had not paid attention to the information given about Greg giving Andrew money and that Andrew now had 72p, not just the 38p he had found in his own bank. She had suddenly said out loud, 'He's got 38p'

R, Has he? Are you sure about that?

Sara ignored this question and continued to pursue her interest in the stamp. It was therefore considered to be more responsive to her needs to offer an explanation about the postage stamps rather than pursue the accurate arithmetical facts that would eventually permit her to solve the problem correctly. Nevertheless, she was brought back to that at a later time. The information about the stamps was not needed for the solution of the arithmetical question, but knowledge

about the postal system contributed towards an understanding of the story. Although she was permitted to wander off from the goal of the story for a short time to pursue her interest in part of the text, R. effectively 'held' that part of the text for her, and then brought her back to it.

The extract below illustrates the group attempting to scaffold Sara who remained relatively uncooperative throughout. She had made up her mind and it would not be changed by persuasion. Nevertheless, the various group members add to each other's examples of reasons

- why we must pay for a postage stamp and
- why anyone would want to send a post card.

The children are not repetitive, but increase their arguments for paying for stamps rather than just agree with each other. Sometimes, when a child had said something, the others agreed, and then developed the idea. For instance, the group all agreed about the need to have a stamp to post letters and spoke around the subject for a little while to the extent that they seemed to be losing the thread of their argument, but they later returned to it to tell Sara that the postman would not take a letter without a stamp. It seemed, therefore, to be simply that they were discussing what they found interesting about stamps until Sara absorbed this information or until someone else came up with a better argument.

Sara. If Andrew had 38p how did he not have enough?

Jack. The stamp cost money.

Sara. Why does he need to send a postcard?

Jim. To tell him he's arrived and let him know

Sara...But does he need a stamp?

Gr. You need a stamp to post letters. *Discussion about where to buy stamps locally and their nearest post boxes.*

Sara looked thoughtful.

I had a sudden concern that perhaps Sara had not posted anything.

R. You look at every letter that comes into your house and it's got a stamp on it.

Sara considered this for a few moments and agreed that they all had a stamp on them. There was some conversation about the appearance of stamps. One child had received a postcard with a very colourful bird, but could not remember where his relative had been on holiday. Sara listened intently.

Sara. Why do you need one but?

R. To pay the postman.

Sara. It's a waste of money.

The group were becoming a little restless, as they knew that stamps were necessary. In order to maintain their interest and keep them on the end goal of this particular task of interpreting the text of the story, Sara had to be moved off her stamp issue by being told the fact of the matter.

R. No! You've got to pay for the letter or card to go on the train or plane and to pay the postman.

Sara was thinking about this, but the group quickly reinforced this information.

Gr. You've got to pay for it or they won't take it...you've always to put a stamp on...etc.

Sara. But you've already paid for the card.

R. Yes, but to send it you have to pay the stamp.

Although this seemed to bring Sara's discussion to an abrupt end, at this point it was necessary to maintain the interests of the others. This final statement effectively offered Sara an idealized path of interpreting the text of the story because her notion that the stamp was unnecessary unhinged the meaning of the story. Her misunderstanding is unlikely to have caused her difficulty in

forming an arithmetical equation for the solution of the problem because the price of the stamp was not relevant and was therefore not mentioned. Unfortunately, she was so engrossed with the stamp that this aspect of the story, which should have been incidental, was totally preoccupying her thoughts.

This discussion had started off with aspects of scaffolding such as a simple checking that the children had the necessary background knowledge for the task and making the connection with out-of-school experiences, but had ended up with one child being given information by all the others within the group. The fact that each added to the discussion indicates that they were developing their thoughts on the text and organizing their knowledge. This demonstrated how the group listened to one another and added to the information rather than simply agreed with the previous speaker and so reached a shared understanding of the text. The story line was held for the group while Sara struggled with her lack of understanding, but the group was brought back to the point where they had stopped when it was appropriate to do so in response to their needs, which in this instance was a maintaining of their interest and keeping them on task. This was the first story with an arithmetical question at the end of it and Sara had changed tack from refusing to buy stamps to talking about letters:

'You buy with the stamps stuck on them.'

This was distracting the group from their task, and knowledge of the postal system was not going to contribute towards the solution of the problem, so Sara was kept on track:

R. Yes but to send it you have to pay the stamp. Matt, read the arithmetical question.

Matt. Andrew had 38p in his bank. The stamp cost 28p. Andrew did not have enough to buy a postcard. Greg gave him money. Now he had 72p. How much did Greg give him?

This was the first story with an arithmetical question attached and it was important that the children should be scaffolded by:

- checking their understanding of the relevant parts of the text for the formation of the arithmetical equation,
- analysing the task for them and
- emphasizing the features of the task.

R. How are we going to find out? What is the real question there? What is important?

Jack. How much Greg gave him.

R. Is the cost of the stamp important?

Gr. No.

R. Is the cost of the postcard important?

Gr. No..... yes, it is!

The group were unsure of how to respond to this type of questioning. These questions were asked as a means of guiding the children to clarify the meaning of certain parts of the text in their minds. Some of them may have been more familiar with the method employed by many teachers of questioning children in a manner in which each incorrect response is presented - and the children know the answer should be negative - until the final response is given to them evoking a positive answer, for example:

Teacher: Did Goldilocks eat Papa Bear's porridge?

Class: No!

Teacher: Did Goldilocks eat Mama Bear's porridge?

Class: No!

Teacher: Did Goldilocks eat Baby Bear's porridge?

Class: Yes!

Jack No...it isn't!

Sara...*ignoring proceedings*.... $38+28$.

R. Sara, be quiet for a little minute and listen to what Jack has to say. Sara has to be kept on task and not allowed

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to distract the other children from their work. Does it matter how much the postcard costs?

Jim. No.

R. Does it matter how much the stamp costs?

Jack. *and some of group...* No ..

R. What are we being asked?

Gr. How much Greg gave him.

Liz. How much the postcard and stamp will cost?

Don. No! It isn't! It's asking usHow much did Greg give him?

Liz did not understand.

Liz clearly needed to be helped with the question. It was read aloud for her as she sat reading the text silently.

R. Andrew wanted to send his Grandad a postcard when he went on holiday. He took his money out of his bank. Andrew had 38p in his bank. It was not enough to buy a postcard. Greg gave him money. Now he has 72p. How much did Greg give him?

R. Liz, we're not being asked about the stamp or the postcard but how much Greg gave him. Do you see the question at the end? Liz nodded. You are going to imagine AndrewHow much does Andrew have in his bank?

Matt. 36p. He had finished the sum and was listening but not looking at the text.

Gr. 38p!

R. Andrew has 38p and everyone says that was not enough money so he went to Greg who tipped his bank out and said 'I've some money in my bank here' and

Greg rattled some money into his hand. Andrew counted all the money and he ended up with

Don. *Interrupting* 72p.

At this point all the group had finished the word problem and were listening.

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R. How much did Andrew have to start with?

Gr. 38p

It may have helped Liz if we had coins and counted them out to let her see the difference. However, we had a bank that was used to collect any unclaimed money found in the room and one child pretended he was Andrew taking out the 38p and another that he was Greg giving Andrew the unknown quantity of money.

R. How much did he have at the end of the story?

Gr. 72p.

R. How much did Greg give him?

Gr. 38p, 32p....37p.

The children from one particular class within this group had already shown signs of being inexperienced in some arithmetical skills that were in their mathematical curriculum.

R. How are you going to find out how much Greg gave him?

Gr. Shouted out numbers. Kate was sitting thinking.

R. Kate?

Kate. I think you take the 38p away from 72p.

R. That's right! If you take away all Andrew's money then you will find out how much Greg had.

Kate had finally found the correct equation for the solution to the problem. She was not permitted just to follow the instructions of the group, but had the problem explained and demonstrated to her until she suddenly smiled and responded.

As the group progressed through the stories, some quickly used the text to aid their understanding of the arithmetic question at the end, but sometimes someone needed help with the mathematical words or the syntax of the problems. In this question at the end of the story about children gathering nuts in the park, the insertion of the word 'more' in the conversation is problematic when the word 'less' in the question caused problems:

Mum, Daniel and Cameron were gathering nuts in the park to help the squirrels find food for the Winter. Cameron found 58 nuts. He had 26 less than Daniel. Mum had 69 nuts. How many nuts did Daniel collect?

Sara. Cameron has 26 nuts.

R. What does it say, Ann?

Ann. Cameron has 58 nuts. That's 26 less than Daniel.

R. So how many nuts does Cameron have, Sara?

Sara 58.

R. Now ...

Sara It says that Cameron has 26.... no it says that Cameron has 26 less than Daniel. Daniel has 26 more than Cameron.

R. That's very good.

Jim did not know what to do, which was surprising as he had always seemed to be the child who needed the least input in the group. He was watching the work of the others, but had not listened to Sara and her explanation that 'Cameron has 26 less then Daniel' can be changed to 'Daniel has 26 more than Cameron' because he was rather inclined to opt out of her discussions. Liz stared at the text. Sara did her workings out loud throughout the explanation for Jim:

R. We don't know how many nuts Cameron has until we work it out but we know Cameron has 26 nuts less than Daniel and another way of saying that is to say that Daniel has 26 more than Cameron.

Look at the arithmetic question

Jack Do you add 26 and 58 ?

R You tell me!

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Sara. It does.

R. How do you know?

Sara Because I did it!

R. But what are the words that let you know that it works?

Sara. Because Cameron has 58 and Daniel has MORE than Cameron. He's got 26 more than Cameron. So it's 58 add on 26 and that's 84. She was pointing to the part in the question where it said that Cameron had less than Daniel.

R. Do you understand now Jim?

Jim needed some more help with 'more' and 'less'. Two children were used to demonstrate this with a two bundles of cubes. Jim was asked to identify the child with less, then the one with more. Then he was told to pretend that the child with less cubes was Cameron and the child with more cubes was Daniel and to imagine the cubes were nuts. He suddenly knew how to transpose 'more' and 'less'. Although Jim was very confused by the use of 'more' and 'less', but by demonstrating the meaning of the words, he came to an understanding of them. Some of the children needed some help with their basic arithmetic. Don was very annoyed because Sara leaned over him and told him the answer. The children obviously took pleasure in doing work by themselves, although it was very apparent when any were having some difficulty, even to someone who was not their class teacher and not fully aware of their proficiencies. Their eye and body movements were very good indicators of their confidence in their abilities to solve the problems, while a quick check on their written arithmetical equation, which was clearly visible, revealed their level of accuracy.

The Primary Four Group.

The mathematics curriculum for Primary Four in Glasgow introduces addition and subtraction in hundreds, but the children

do not go on to thousands until the following year. The arithmetical word problems used numbers that gave answers less than one thousand. These children were eight and nine years of age, consequently their stories were slightly more complex and the characters were more defined and their circumstances reflected those of the children a little more closely than in the stories for Primary Three. Therefore, the Primary four group had a single parent and children who were football or rugby fans. Nevertheless, it was important to cater to all tastes, so there was one about a leprechaun and another about a giant, both of whom had featured in the reading books that were part of the school language scheme.

Although all the children had been taken along to the room allocated to the Main study to acquaint them with it and to be told the goal of the study, each printed story was given to them with an introductory reminder of how we were going to think about short extracts from the stories at a time, the general rules about listening to each other and permitting everyone to take part in the talking. We always started with a short discussion relating their experiences to the title. This was to place the story within their knowledge and give them a 'hook' (Kintsch 1998) to hang any new information.

R. I want you to read this story and really think about what I means. What is it called, Paul?

P. The visit.

R. Have any of you ever been visiting someone?

Gr. *There was a discussion about the various visits some of them had made to relatives.*

Many seemed to consider visits to be either an irregular occurrence or something that happened regularly but not particularly frequently. For instance, going to a Grandparent's house on the way home from school or staying there every

weekend was not considered to be a visit as it was part of a regular routine. Any new information gained by the children from the stories may not only widen their own experiences of e.g. family visits, but may deal with the different emotions experienced by others. We can never truly understand how others feel, so the inclusion of emotions and the exclusion of all the details about the characters in the stories presented the opportunity to instil in the children that there is a difference between known facts and deduced facts (Ruffman 1996). Sometimes it was easy to assume facts about a character, but a careful reading of the text may reveal another aspect that would lead to a different conclusion.

In 'The Visit', the children were introduced to a Great Aunt and her niece's children who were going to be staying with her. The Great Aunt seemed to be a little unconcerned for the children at the start of the story. However as the story ended, it was revealed that she was different from any grown-up they had ever known. The children had to change their opinion of her as the reading of the story progressed.

R. Why are these girls not happy to stay with Aunt Mary?

Joe She's horrible.

R. Does it say that?

Gr. No. They scanned the text, but it did not say she was unpleasant.

Joe She's cheeky?

R. Does it say that?

Gr. No.

R. Do you think Mum and Dad would send them to someone who would treat them badly?

Joe . Maybe she's nice when they are there...

Amy. Reading...Internet until after 6 o'clock.

R. What do you think of those rules?

Paul. Boring,

Amy. Strict...

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There was nothing in the text to suggest that Great Aunt Mary was in the least bit strict with them, however, some of the children had made up their minds. In fact, the story stated that there were few rules, many outings, little housework and amazing meals.

R. Do you think so? What's strict about those rules?

It was important that the children realised that they had not interpreted the text accurately, but had merely formed an opinion at the beginning of the story that may or may not have been correct. However, as the story progressed, there had been ample evidence that their first idea of the Great Aunt was wrong, and it was important that they should learn to keep an open mind when interpreting text. One of the children connected her instruction to keep off the Internet until after six o'clock with his own experiences.

Max. It's because she has to be with them because it costs money.

R. Do you think those are strict rules?

Max No, they're sensible because the Internet costs money and they might break the computer.

R. Are there any other rules that she mentioned?

Gr. No.

By the end of the story, the children had changed their minds:

R. What would you like about Aunt Mary?

Gr. bedtime, cooking, e-mails, her driving...

R. You started off not liking her and now you like her.

As the sessions progress, the children were reminded about the hasty conclusion that many of them had made about Aunt Mary and that sometimes it is not wise to make up their minds quickly. They were told that a better approach to stories is to look for all the facts and listen to ideas from others before they formed a

definite opinion because of a few sentences. This was direct teaching because it was necessary information for an accurate interpretation of the text and, as such, was a scaffold because it was teaching them what they did not know. They were encouraged to adopt this attitude to prevent them from focusing on a few facts in the stories, and later the arithmetical word problems because it is at this point that many children make mistakes when they do not consider the whole of the text, but use either key mathematical words or a misinterpreted version of the text to form the arithmetical equation (Gravemeijer 1997 and Hegarty et al 1995).

It is difficult to overcome procedures which have occurred, (Meadows 1993) either accidentally or by encouragement, therefore it is sometimes important to practise a skill in order to fully internalise it. In attempting to scaffold a group of children, as with any classroom interaction, it is not possible to be absolutely certain

- that all the children have reached understanding,
- about the depth of any understanding which may have been reached and
- that the children will remember to use what they have learned.

One of the purposes of the study was to teach the children the importance of interpreting the text accurately, without allowing their imagination to alter the meaning. The children had seemed to be aware of the importance of scanning the text for facts and recognizing the difference between imaginative speculation and facts by the end of the reading of the first story. Nevertheless, children have fertile imaginations and they are usually encouraged to use them, especially in the language domain, so it was to be expected that there would be the need to revise and reinforce the art of accurate interpretation. The stories were deliberately simple in format although ridiculous in content in an effort to hold their imaginations while they learned to interpret the text. In this extract

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from 'The Holiday in Ireland', the children were asked about the number of people on holiday in Ireland. The answer was either

- a) the core number of five in Greg's family and that there were various other relatives, or
- b) that the number was not given.

Greg was on holiday in Ireland.....

R. How many people were there on holiday?

Gr. Various guesses.

None said they did not know although it had been emphasised in the previous session the day before that sometimes it was not possible to know all the facts from the text. The question may have been misleading as some teachers ask questions about a text if the answer is easily extracted, and the group may have been expecting this approach. Nevertheless, it had been stated at the beginning of the session that they had to think very carefully about what the story really said and not to guess what was not in the text. As the children did not implement this advice, this provided an assessment that the children needed further scaffolding in considering the facts that were stated in the text as opposed to their own opinion of the text.

R. How do you know how many relatives were on holiday?

Gr. I just think etc...

R. Can you tell? Does it say?

Gr. No.

R. What would you need to know to be able to tell how many were there?

Amy. How many Aunts and Uncles.

They had now identified the unknown quantity in the text and realised that they could not give an accurate answer because part of the information was missing.

R. Do you have a picture in your mind of this house by the sea?

Sally There was a garden and a horse.

R. I wonder what the horse looked like?

Max All brown and white.

R. Could be...Some things in stories... you can use your imagination for, like the colour of the horse, and you cannot tell if you are right or wrong, but other things you are told.... If I said to you was the horse black?

Gr. You wouldn't know.

This focused on a reliable strategy for accurate interpretation of the text, namely checking all the information available in the text. It also reinforced the instruction from the previous day and reminded them of routines they must employ.

R. That's right. Some things we know because we are told. Some things we can imagine, but we can't say whether we are right or wrong because we are not told. So someone could imagine a black horse and someone else could imagine a brown one and unless we are told, we can't say one is correct and one is wrong.

It was interesting to note that one child thought that the dog barking at something in the field was unusual rather than the appearance of a leprechaun.

Mike...reading...Sophie in field....

R. Is there anything unusual here?

Sally. The dog kept barking.

Amy The man is smaller than his baby sister.

Gr. The wee people who have magic powers in Ireland...

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A leprechaun and giants feature in their class reading books and had been introduced to make a link between what they already knew and the new materials.

Although the earlier session emphasised the interpretation of text of the stories, it was vital that the children should apply this skill to the arithmetical word problems. Therefore, the scaffolding processes were applied when the children first encountered a problem at the end of a story. The information first appeared in the story, so the children were guided through this. It was expedient to check their understanding of the necessary facts for the solution of the word problems while they were reading the story and thus provide a further link between the text and the problem.

R Read that bit again, Mike, about the photographs.

Mike. Aunt Mary.....

R. How many photographs did Aunt Mary count out?

Joe. 27.

R. What about this 9, 4 and 14....what is that about? *The group scanned the text.*

R. Aunt Mary counted out 27 photographs. What were they?

Jake. Pictures of the family.

Lily. Pictures of Grandad when he was a boy.

R. How many did she have of him?

Lily. 9.

Jake 7 of his wedding.....

R. No, it's actually.....(Jake had a history of confusing 4 and 7.)

Gr. 4. And 14 of Mum and Auntie Nicola when they were little and 9 of Grandad.

R. So how many did Aunt Mary give to them?

Gr. 27. *The children were aware of the fact that the numbers 9, 4 and 14 formed the total, 27.*

Just before the word problem, a short paragraph was inserted to suggest steps for the children. Although this was read to them with a few recommendations and clarifications, it was also printed to permit them to have visual guidance for revising the process:

Think about the photographs and what you are told about them. Think carefully about how many Aunt Mary gave the girls. Perhaps you could draw a picture to help you think about this story.

The pictures, which it was suggested that the children draw, were simple match-stick type drawings of Aunt Mary giving the children the twenty-seven photographs and the children with the album with the forty-three photographs in it. This was to reinforce the importance of these numbers and to help the children to consider the relationship of these numbers to each other and their significance for the formation of the arithmetical equation. As this was the first arithmetical word problem which they had been given at the end of a story, further guidance and help was offered to those who needed it. First, they had to be reassured that the solution was within their grasp.

R. This part down at the bottom where it says arithmetical sum - which sounds difficult but is really very easy...Read it in a big loud voice, Lily.
Lily...*Read the arithmetical word problem.*

Then the important steps for the solution of the problem had to be identified by breaking the information down into smaller parts.

R. How many did Aunt Mary give them?
Gr. 27.
R. How many did they have at the end?
Gr. 43.

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Finally, the idealized path had to be given to them and they were told to solve the problem:

- R. Think about how many did they have before Aunt Mary gave them the 27 and write the answer down.
- Gr. Some discussion and comparing of answers.

Some children were confident with their ability to tackle the task alone, but a quick overview of the workings and the obvious hesitancy of some children to start indicated that some needed more assistance. Jake had exhibited a very individual approach towards arithmetic since his time in the Infants because his Mother had taught him to count on rather than back when he was learning subtraction. In school, when he was doing a simple sum, e.g. 9-5, he was given 9 cubes, or little illustrations in his textbook and taught to take 5 away to find the answer 4. At home, his Mother had always encouraged him to count from the lower number using his fingers until he reached the higher number. Although he recognized subtraction sums, he frequently needed assurance that his counting on was acceptable rather than writing the sum in a more conventional subtraction format of

$$\begin{array}{r} 43 \\ - 27 \\ \hline \end{array}$$

R. Jake, think about the two numbers....and do it any way you want to do it. Write anything down - there's plenty of space. A few of the children had started writing down the numbers from 27 to 43 to count on to find the answer. How many did they end with?

Gr. 43.

R. Of the 43, how many did Auntie Mary give them? How many did they have by themselves?

Lily 16. I took the 27 from 43.

Luke I counted on from 27 to 43.

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Joe. I added on 10 to 27 then I added on....37 to 43.

Cara I added on...27 to 43

Sally: I counted on. (Sally had some difficulty but wanted to count on and had written all the numbers from 27 to 43. Max showed her how to put a small line down and cross off in sets of 5.)

Max had scaffolded Sally because she knew which information to use to solve the problem, but she did not know how to organize it effectively. He took over that part for a little while he demonstrated how to do it, then permitted her to continue on her own when she indicated that she understood how to do it by herself.

Joe eventually managed to complete subtraction sum using a conventional format for a subtraction sum.

R. Lily...You wanted to do a subtraction sum, but you got a little mixed up. You should have put the 43 on the top line. Lily had written the 27 on the top line, but was still trying to subtract it from the 43 :

27

-43

This child had the correct arithmetical approach and her answer should have been accurate, but she needed more help with her basic arithmetical skills. Telling her to write the sum in a particular way enabled her to complete it by herself because the part of the task that was problematic for her was taken from her and demonstrated the idealized path.

The Primary Six Group.

In an attempt to compare the effectiveness of the study, it had been decided to give all the children the same type of arithmetical word problems that could be solved with either an addition or a

subtraction sum. Although the numbers seem to be rather unwieldy, this imitated the sums in their textbook, Heinemann 6, which they were just completing, and the book, Heinemann 7, they would be using immediately after the summer holiday, for example:

4772

- 2564

_____ (Heinemann 6 page 4.)

	banapples	peachcherries	lemoranges	plumpears	kiwiberries
Ecolab 1	2187	3081	1102	8230	9416
Ecolab 2	1343	793	657	3578	7807

1.Find the total number of each type of fruit in Ecolabs 1 and 2.
(Heinemann 7 p3).

It was difficulty to absorb these numbers into a text that was in some way related to the experiences of the children. The class teachers had been asked to suggest suitable topics for stories, but the range of interests of the children was wide and the contents of the school library was narrow. Therefore the stories for the Primary six group were varied, although it very soon became apparent that those that appealed were the ones with highly eccentric or exaggerated characters.

This Primary six group had two very dominant girls in it who both came from the same class. One of them, Mary, was very inclined to ridicule any other child who hesitated in responding to answers. Although it would have been helpful to have knowledge of this trait before the sessions started, the teacher had declined to mention this for fear of labelling the child as a troublemaker. For the sake of equanimity and peace within the group, Mary had to be taken alone and be conscripted into assisting with the group. She was asked to assist the others a little more when she noticed that

someone was struggling, to encourage others to talk and help them to work by not always shouting out answers to questions when someone else was addressed and a little hesitant at answering. Although her attitude towards the other children was unexpected, it did indicate the introductory session should include not only the procedures of listening and helping each other and the goals of the sessions but also more specific rules about group behaviour. Positive behaviour had been emphasised, with the assumption that children would know what was not acceptable, but it would have been easier if acceptable and unacceptable behaviours had been specified at the very outset.

This group had very vivid imaginations and were very quick to make connections between the text of the stories and their own experiences. This was important because the arithmetical word problems are frequently considered to be isolated from the life experiences of the problem solver (Walkerdine 1988, Dowling 1998) In the story, 'Normandy' the children immediately contrasted the holiday related in the story to their own experiences.

R. Can you tell me anything about their holiday, Sue?

Sue. They're always different. When we go on holiday, we don't take all the family.

R. Who do you go with?

Sue. My Mum, my Dad, my little brother and my two little sisters.

R. Right, but you don't go with your grandparents and everybody else. So this is a very unusual holiday. What would you say about going on holiday with people like these?

Meg. My holiday's different. I don't like my Gran coming because she doesn't dive in the pool with me.

R. I thought that would have been an advantage - diving into the pool by yourself. Do you like your Gran to dive into the pool? Is she good at swimming?

Meg. My Grandad's better. He does the 'bombs'.

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R. Uh?

Meg. He jumps off the diving boards.

R. Does he?

In the story 'The Move', the children's tendency to exaggerate became apparent again.

Ian. How good was the news going to be she wondered.

R. I'll stop you there. Ian, what do you think about having your Mum working in the school? *Ian's Mother was the school auxiliary and was known to all the children.*

Ian. Terrible! I don't like it.

Sue. It would be dangerous having your Mum working in the school. No fun!

Mary. See if my Mum was the dinner lady - she would burn every bit of dinner.

R. Is she a dinner lady in someone else's school?

Mary. No. I like to do my own cooking at home.

Gr. My Mum is an excellent cook...I do my own....and my ironing.

R. It would be bad enough having your Mum as the dinner lady, but imagine what it would be like to have her as your teacher...

Gr. Dead embarrassing. I'd hate it. Awful.

Fred. She could give you full marks.

Gr. No...I don't think so....That would be good....

Sue. No she wouldn't give you full marks. She would give your friend full marks.

Gr. She would bring in photos of when you were wee
..And tell stories...

R. Your Mum doesn't do that, does she Brian?

Ian. No...But she always talks about me.

R. Does she?

Fred. No she doesn't.

This group had to be frequently brought back to the task on hand although it was desirable that they relate the text, no matter how

ridiculous, to their own experiences. Each paragraph was discussed to check that the children understood the meaning and were always alert and concentrating on the text.

R. 'Don't look a gift horse in the mouth.'..... Rachael
(*in the story*) said that she didn't understand it, but what
did Grandad say that it meant?

Mary. Not to criticise.

Ian A present.

Gr. Some discussion about the expression 'a gift horse'.
Although some had heard it before, none knew the origin
of its meaning.

R. If some one gives you a horse as a present, don't look
in its mouth because it may have bad teeth and that will
let you know it is really an old, not very good horse; but
it's a present so you don't criticise. If you're given a
present, you don't start to examine it, you just say, 'thank
you.'

Mary What does she mean about the horse?

She had not been listening to the explanation, although there had been no outward sign of this and had been one of those who had enquired about the meaning. Nevertheless, she herself asked for further clarification of the part of the text she did not understand, which illustrates a child asking to be scaffolded.

R. This is an expression Grandma uses. She means as
Grandad said, *interrupted by group*....

Gr. Never criticise a present!

Sometimes controversial characters were introduced to the group to encourage them to discuss the meaning of the text. It was important that they go beyond the words on the paper when they were talking about the stories in order to attain a shared understanding of the meanings (Maria 1990) Each of them had different experiences within their families, so their interpretation of

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the texts may be different, but it is only through communication that they can share these understandings. This sharing of understandings may enable children to add to their knowledge, as it is within society that we learn (Vygotsky 1978). One authoritarian grandmother expected fathers to do the garden, mothers to cook, wash and iron the clothes and make the beds, and children to do all the rest of the housework. The children had various views on this approach to life:

Gr. Terrible!

R. What's terrible?

Gr. I don't think children should have to do anything.

She asked them to do too much.

I think children should only have to play the computer, watch TV, watch videos...listen to music.

I think children should do their fair share.

R. What's that, Mary?

Mary. They should tidy their own room.

R. What do you think about Mum doing all the cooking and all the washing and everything?

Gr. I think that's very good.

At the time this response seemed to be a fairly predictable reaction on the part of young people to the suggestion that they do housework and was not discussed further. Later reactions to the text hinted at stereotyping:

Lily. (*Reading from text*) I'll show Gran how to work the computer.

Gr. *Some laughter at this suggestion and talking about their own Grandmothers ever working a computer.*

Lily *Lily had some difficulty reading the e-mail address, but Fred read it for her without a break in the flow of the reading.* Mum

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used a computer at work all day and would not go near one at night.

R. Tell me about this 'http:/' *indicated text.*

Sue It's a code.

Fred. It's an address. It's an Internet address.

R. Yes, it's the start of a lot of addresses on the Internet.

Gr. Some discussion about computers and how some mothers were learning to use them at work.

This group discussed how to tackle the arithmetical word problems that were given to them at the end of some of the sums.

R. Think about Gran talking about the recipes. Think about the information she gives you about the number of recipes. Think carefully about all this information.

Now look down at this part where it says 'Arithmetic Question.'

SOAR has 1347 recipes: 326 main courses and 93 soups and the rest are puddings or cakes. Gran has 187 soups, 403 cakes and 174 main courses.

Who has more recipes, Gran or SOAR?

Now quietly think for a few minutes about how you are going to do it.

G. Can you do a sum?

Mary It's easy. To me it's obvious.

R. It's not always obvious, Mary. This was to encourage children who were thinking about the text of the problem and who would have found Mary's confidence disconcerting.

Mary Yes it is because you know that Gran has more than....(grimaced at her own mistake and shook her head) SOAR has more than Gran.

Mary's error, which was a slip of the tongue made in her haste to demonstrate her knowledge, was not recognized as such by most

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of the group who were looking at the text rather than watching her.
Her slip-up started a discussion among the group.

Fred. Yes that's right....he did not immediately indicate which part of M's statement he considered to be accurate.

Gran has.....scanned text.

Mary 712! Her arithmetic was inaccurate.

Max. Add 187 and 403? He sounded vague and unsure of himself.

R. So how are you going to figure out the answer?

Max. Add them.

R. Read them. Read them, Max. He was staring into space, thinking.

Max needed to be kept on task and to be directed on a course of action.

Max. Add all the numbers!

Meg. Gran's got a lot of numbers. She's got four. Gran had three numbers, but before this could be pointed out to her M interrupted.

Mary. That's wrong. You don't need all the numbers.

Max. Yes you do.

Mary Gran has360. Her arithmetic was inaccurate again

Max. Add them all.

It had been apparent on a few occasions that Max did not like to be corrected or encouraged to alter his opinion. Although he extended this attitude to all of us, he became stubborn and argumentative when Mary disagreed with him, even when she was correct.

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R. What do all the numbers tell you? *Addressed to Max.*
There was no response because he was so engrossed in looking at the question.

Fred. No because, look you're wrong, she's right. *Addressed to Max who was sitting beside him. He was looking at Max's work.*

Max. Add them all.

Ian. Add 1347 to what? *Ian. was at the other end of the table and could not see Max's work. The rest of the children looked at Max waiting for a reply.*

Michael's instructions were unclear and no one could decide whether he intended to add every number in the question or only the number of Gran's recipes.

Fred. That's not what you do. *Addressed to Max as he pointed to the work on Max's paper.*

Mary. Look you add that to that and that. *Addressed to Max as she jabbed her finger on 187, 403 and 174.*

Fred. Look.....*indicating Max's working.*

At this point, it seemed that Fred was more determined to gain some sort of dominance over Max rather than help him. Fred's approach was the accurate one as he conceded that Mary was correct, but he was not assisting Max in his understanding as he was merely telling him he was wrong. Although Ian had tried to clarify Max's intentions for the group, Max had not responded to him and had remained silent when Fred and Mary had seemed to join together to correct him.

R. Fred, listen to what she has to say. *This was to silence Fred who just wanted to tell Max that he was wrong.*

Mary, explain what you think.

This was encouraging Mary to scaffold Max because she knew the answer and had been overheard assisting Lisa.

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Mary. It tells you here. *Indicated text. S.O.A.R. has 1347 recipes and Gran 187 and 403 and 174. So Gran had* She trailed off looking at her addition sum which was probably inaccurate.

R. So why do the other numbers have nothing to do with the sum?

Lily. She's right. *Addressed to R. Max was shaking his head, disagreeing with Mary.*

Fred. Look! *Addressed to Max. Fred was becoming annoyed with Max's unwillingness to listen.*

R. Shh, Fred. Explain, Mary. Why...

Mary. Because that's only telling you it's the main courses and the soups and the rest are*looking for description.* She covered the number with her hand, possibly to indicate that they were not to be used.

Mary and Fred. Cakes and puddings.

Fred So you just add those numbers together. They indicated the number of Gran's recipes. Some of the group had completed the problem and Ian was still watching Max and listening to the interactions.

R. Just take you time Max and read it. *Max threw down his pencil and shook his head apparently annoyed that Mary and Fred had understood the sum and he did not, or that Mary was asked to explain it to the group or unconvinced that he was incorrect.*

R. How many recipes does SOAR have, Max?

Max. 1347 and 326 and 93.

R. Do you understand when Mary says that you don't need to do anything with the 326 and 93? He looked at the text of the problem very carefully.

This reminded him that not all the numbers were needed to solve the problem and to persuade him to follow the correct way that had

been shown to him. It made him revise and check his work, which is an important aspect of scaffolding.

Max. Yes.

R. Why?

It was important that Max should understand why Mary and Fred were correct and it was necessary to establish the extent of his understanding in order to assist him from that point. If he had not understood why the 326 and 93 were not to be included in the arithmetical equation, it would have been imperative to have taken a step back and illustrated the distribution of the recipes.

Max. Because they are the same recipes. *He pointed to the 1347.*

R. How many does Gran have? Or let's say, 'How can we find out how many recipes Gran has?'

Max, Sue and Meg. Add them up. *They said this and laughed as though it were because they had said it together, but Max was not pleased with them and frowned at them.*

The girls were sitting together and enjoying Max's discomfort. They were careful never to say anything to deliberately annoy him, but they had made a show of completing their sums while he was still disagreeing with Fred by putting their pencils down and turning their papers over to prevent anyone seeing their answers, even each other. Max had to be brought to an understanding of the problem and give evidence by the completion of the arithmetical equation that he knew how to solve it, even though he had made it clear he did not want help from some of his group. Ian, who had attempted to clarify Max's understanding, had recoiled from Max when he had thrown down his pencil and had not made eye contact with him since although he had seemed to be about to speak a few times. He was quiet and needed encouragement to do so, but had seemed unwilling to become involved in the exchanges between Max, Fred and Mary.

R. Which ones? *Meaning which numbers.*

Max., Sue. and Meg 187 and 403 and 174.

R. Right.

Fred. Oh no, I've done it wrong. *He noticed an error in his computation although his equation was accurate.*

R. Gordon, have you written the answer down?

Gordon. Oh, no. It's wrong. *Gordon was listening to Max, Fred and Mary and looking slightly bemused at the girls who were smiling at Max in a somewhat triumphant manner.*

R. You weren't reading the question. Pass the rubber over to Gordon. *Gordon had been listening to the dialogue, and had suddenly realised that he too had counted all the numbers in the text because he had been writing them while listening.*

R. At the end of it all what is the question asking you?

Fred. Who has more?

R. So what is the answer?

Meg 764!

R. So WHAT is the question asking you?

Meg. Oh! A name. Who has the most? So it'sShe pointed to 'SOAR' in the text.

R. Just leave the sum, but write down the word you were asked for. Addressed to Fred.

R. Gordon, do you understand how to do it?

Gordon Yes.

R. How are you going to do it?

Gordon seemed to have realised where he had made a mistake, but he had to be offered help if it were needed. He was asked to state his own understanding and how he was going to reach a solution to assess the need of assistance.

Gordon. Add.

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R. What?

Gordon. Add 187, 403 and 174.

R. Max, what are you going to add?

Max. The ones there. (Indicating numbers on paper)

R. That's right. Why?

Max. Because those are the ones they're asking you about.

R. What do you have to do to answer those questions?

Max. Never mind that and that. (Indicating extra numbers in text.)

At this point Max laughed, lifted up the paper and tried to show something on the page to the others. Ian pulled a face at Max and turned away. Few looked at him because he had been scowling at most of the group for part of the session.

R. Just read the question and answer that! Max was comparing the arithmetical word problem with the text of the story. A typing error had been made because Gran claimed she had 387 soup recipes in the story, but the arithmetical word problem text stated that she had 187. He was pointing this out to the other members of the group, possibly in an attempt to excuse his earlier error.

R. You've got to look and think about what the question really says. Even at the end you were going to write down a number rather than a word, weren't you Meg?

Meg. Yes. *Laughing at misunderstanding.*

R. How many of you were going to write down a number rather than a word?

Max. I was going to write down the sum, then Gran.

R. That's all right. But Ian, Gordon and Meg were going to stop at the number. But you have to read the question and say, 'What does it REALLY say?' Then you have to go back and say, 'Where am I going to get this information from?' Look at the numbers and, as Mandy says, they are not all needed, so you have to think about the question and how you are going to find the answer.

This summarized a successful approach to the arithmetical word problem. Although many of the children thought they had successfully completed the word problem, they had failed to read the whole of the question accurately because they had given the total number of recipes owned by Gran, although the question asked 'Who has more recipes, Gran or SOAR?' and a name, not a number was the answer. Mary, the child who knew from the outset how to solve the problem had made mistakes in her basic arithmetic on two identifiable occasions even within that problem. Gordon had been so caught up in the verbal exchanges within the pupils that he had failed to notice his own error and needed reminding on the importance of checking his work for accuracy. Ian opted out of communicating with Max although he still joined in with the discussions that were going on among some of the group as they checked work and discussed the best way to do the addition sum. The children had remarked on SOAR when it appeared in the story and asked about the recipes, so discussion at that point may have helped some of them appreciate that the 1347 recipes included the categories of main courses, soups, puddings and cakes because it was compared to a recipe book with different parts to go to for different menus.

Max's demeanour that particular day demonstrated how a child must be a willing participant in the process to permit learning, teaching and scaffolding to take place. It had been clear from the start of the session that he was annoyed with certain members of the group who were his classmates, perhaps because of an earlier incident within their own classroom, and this eventually extended to those who disagreed with him. There were no directly confrontational approaches made by one member of the group to another that could have been corrected. Max was permitted to calm down and to regain his good humour before any assistance was offered. Even then, help had to be fairly direct to keep him on the goal of solving the problem, which he did successfully.

The Primary Six Class.

The class took part in the study after the summer holiday. It was important that the class discussion of the text should involve all the children. Although it was unlikely that all of them would be active participants in each of the sessions, it was necessary that they should all interact with the text either by talking about it, by listening closely to what others said or reacting to it in some way. Sometimes the unexpected behaviour of adults in the stories elicited a response. The characters were frequently engaged in harmless squabbles and pranks. Their approach to life was a deliberate challenge to the children because the previous primary six group seemed to have stereotyped ideas of suitable roles for women and older adults. The number of children did not particularly inhibit the class discussion of this story but there were some who were more unwilling to take part, and those who always had something to say. However, there were obvious reactions by all the pupils, even if it were only a smile or grimace at a friend, because the language content of the stories was familiar and not a challenge to them as readers and was easily related to their own experiences (Kintsch 1998). The stories for the class followed a different format from those given to the groups. There was a thread running throughout the story of a core family group and their friends and relatives. There were clues that the family lived in a local multi-storey (high rise) block of flats. Some members of the family were given mild supernatural powers because the class teacher said that most of the children were very interested in such stories and television programmes.

It was expected that the main difficulty was going to be scaffolding within a classroom situation although it was planned to attempt the scaffolding techniques that were applied within the group situations. It is possible within a class or group to clearly identify when a specific child has been scaffolded because of the personal interaction between tutor and learner, yet other children who are

listening benefit from the verbal interaction and therefore may be effectively scaffolded. In most classroom learning situations, some children can quickly grasp the goal of the task and choose to tackle it by themselves. If they can be assessed to be doing the task correctly, then to offer help would be an intrusion in the learning process unless they indicate that it is required. The format of these sessions was designed to encourage discussion of the texts of the stories that would disclose the needs of the children. The stories contained intentionally exaggerated characters and situations to make it easy to identify any unresponsive child who was not paying attention to the discussion. The children were encouraged to participate, both in reading and discussion. To overcome one practical difficulty of having a teacher and class meet up who were relatively unknown to each other was to have large labels with the child's name displayed prominently at each place. Unfortunately, only time spent together develops a rapport and understanding between teacher and pupils which allows for quick and easy assessments to be made of children's difficulties or concerns with work, usually recognizable by subtle and personal behaviours or facial expressions. A visiting teacher depends on more direct approaches, such as questioning the children, observation of work and responding to the requests of the children for help. The end result is similar in that the children are helped, perhaps not at precisely the moment they need it, but this can never be guaranteed in any classroom situation.

At the start of each session the children were reminded that we would stop frequently to discuss the text. After the experience with some dominant members of groups, it seemed wise to draw up a list of appropriate behaviours from the outset. Therefore, as a class, we talked about suitable rules which all had to follow such as

- following the reading and concentrating on it,
- putting up a hand to attract attention,
- listening to whoever was talking and

- respecting one another's point of view, disagree with another person politely.

As the sessions progressed, it became apparent that the children were used to discussions and sharing opinions without too many formalities. Therefore, interjections were permitted if they contributed to the flow of the discussion and did not detract from the task on hand.

The class were very attentive and responsive from the first session. The first story introduced Jeremiah and his family, although the information given was deliberately nebulous to permit the children to be taught that there was sometimes a difference between what the text stated and an assumption about what the text stated. The children were encouraged to listen to one another's viewpoint and to give consideration to the opinion of others. Before the study began, certain strategies were considered. For instance, it was expected that within a classroom situation, there would be some children who would not express themselves orally without encouragement while others may try to control the situation. Asking some silent children to state their opinion and praising the articulate for their contribution while asking for the ideas of others on the statements overcame this. Facts about the family were given in each of the stories to encourage the children to listen and remember and to build up a more complete picture of them. This approach was an attempt to reinforce the notion that each session was not autonomous but that what was learned in one could, and should, be applied in another. Those children, who initially did not appreciate this and ignored the advice to remember what they had learned in each session, discovered by the second session that it was more difficult to envisage the characters. Nevertheless, the class made a promising start in their discussion.

In the first story, Jeremiah is introduced and some information is gradually introduced into the text as the story progresses, but in a manner that may have lulled some children into a sense of

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complacency that such information was not particularly important for the development of the plot. However, being questioned about Jeremiah alerted many to the fact that they had to consider all of the text.

R. Tell me all the things you know already about Jeremiah.

The children demonstrated both their understanding of the information that had been given to them so far and the ability to express their opinion on it.

Gr. Dad lost his job, Dad does housework. All hands went up to signal they had something to say and all went down when one child gave the answer. They all thought it was fair that Mum expects him to do the housework because she is out working.

R. What does it mean when it says Jeremiah thought his dad took his role too seriously...

The question was open-ended to promote discussion.

Gr. Dad doing everything.... They spoke about Dad being a little too fussy with the housework and gave examples of what this fussiness could be such as throwing out the newspaper at the end of the day, doing the ironing as soon as the washing was dry, washing the dishes immediately after meals.

The children were encouraged to interpret the story meaningfully as an individual within their own experiences and to share this understanding of the text with others. As individuals, their interpretations of the text could vary fairly widely in that, for example, what was 'fussy with the housework' in one household may be everyday practice in another. Even though 'housework'

seems to be a factual statement, there are different perceptions of the meaning. Grandma was talked about in the first story, but in a past tense as though she were no longer around. The children responded to this part of the text according to their own experiences.

Paul. She's died.

R. Does it say she's died?

Gr. No, it says she's away....

Nora. She may have left him....

R. That's true Nora, but what does it say on the paper?

Tim. She's left him...

R. It says that she had left. She could have died, or left Grandad or gone on holiday.... It doesn't say, but there is a clue that she did not just go out to somewhere like the local shop...Is there a clue?

Sally. She wasn't there when Grandad gave the programmes away.

R. yes. And who's house did they go to after school?

Gr. Grandad's.

R. Yes, it doesn't mention Gran then. So we have a clue that she is away for a long time but we don't know any more than that.

The children were encouraged to share their interpretation of the text in the hope of establishing to a degree appropriate for their age that:

- unless it is specifically stated, interpretation of text is problematic and there is no guarantee that the readers' version is exactly the same as the writer's or other teachers'.
- experiences affect our understandings of situations.

Although it is difficult to scaffold a class of children in abstract knowledge, (Bliss et al 1994) interpretation of the text, which is socially constructed knowledge, should permit scaffolding of individual members of a class by either the teacher or peers.

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Nevertheless, within such a situation, it is difficult to establish whether scaffolding has occurred, as it is not possible to identify and assess every class member who needs or gains assistance during the sharing of ideas. However, in such circumstances, it is necessary to consider that the task has been prepared for the specific purpose of providing scaffolding opportunities for the learners and that the learner is assisted by more competent and experienced peers. An ethos was created within the classroom situation that encouraged participation and requests for help, either clarification of the text itself or of the statements of the peers and encouraged the children to share their ideas. Sometimes the questions were very open-ended to permit children to state their opinion without any possibility of being incorrect and thus encourage the less willing talkers to contribute.

R. So if you saw a big box under the tree would you find it interesting?

Sally. Yes.

R. So any kind of present would be interesting to you?

Laura. Yes! *Laughing*.

R. But you really want a watch? Is there any present that wouldn't be interesting for you? Sally?

Sally. Barbie dolls. My little sister wants them, but I don't.

R. Stuart, what would be interesting for you?

Stuart. I want a video camera.

R. A video camera?

The class were questioned in a way that broke down the task, or made them consider it in greater detail.

R. Right. Stop there. What do you think of Aunt Aggie now? What about the way she dresses and the food she eats?

Class. She's weird. She's a bit out of fashion.

R. What would be fashionable?

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Class. Not the kilt. Purple - I don't like purple. I wouldn't give that food to the cats. *General discussion about food.*

Although the children seemed to wander off the text, they were not permitted to introduce a topic unrelated to the content of the story. Such conversations were not redundant because this unhurried approach was to give time to the children to think about any new idea they may have heard and to ponder it in their own mind. It gave them the opportunity to consider aspects of the stories and information from the perspectives of others.

Some of the children needed the arithmetic question to be broken down into sections. The questions led them through the process to be followed and ensured that they were giving the correct responses that would permit them to form an accurate arithmetical equation for the solution of the problem.

R. Look at **'Jeremiah had 43p and Anna had 76p which was 38p less than Grandad had in his pockets.'** How are you going to find out how much Grandad had?

Class. *Little response...workmen arrived unexpectedly on corridor making it almost impossible to be heard. Putting down piece of wood to hold new carpet in place - expected to take no more than a couple of minutes. Work stopped for a few minutes - attempted to keep class on task by suggesting that they read over part of text until hammering stopped although the workmen moved to another room down the corridor to continue the hammering. The classes have a door and windows on the corridor side, so the noise continued.*

R. How much did Jeremiah have?

Susan. 43p.

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R. How much did Anna have?

Class. 76.

R. Who can tell about Grandad?

? He had 38p more.

R. Who can tell how to find out?

Tony. Add 38p on to 76p to find out how much and that gives you £1.14.

R. Tony - Jeremiah had 43p. - Tom you be Jeremiah.

Tina - your Anna - you have 76p which is 38p less than Grandad - Come on Grandad! - Tony you are so good at explaining it you'll have to be Grandad - Who has more, Anna or Grandad?

The following extract is from the recording of the class who were reading a story about Aunt Aggie who kept her teeth in the sugar bowl overnight to keep them white. It is an example of how the eccentric text encouraged the children to communicate and share meanings with one another while they were thinking about the text.

R. Soup! What do you think of that for breakfast?

Class. General discussion about breakfast food. One child said she loved black pudding and fried eggs for breakfast.

R. But would you have soup with it?

Class. Many agreed that they would enjoy most of the breakfast in the story although they themselves had never had the opportunity of eating such a meal before school.

R. But would you have soup for breakfast? What do you think of Auntie Aggie's cooking?

Class. Rotten!

R. Rotten? Fine. If that's what you think about it.....

Phil. I thought my Dad was bad, but.....*he made a noise to signify his disgust.*

R. Well you can tell him he's better than Auntie Aggie.

Can you read on, Paul?

Paul. Readdipped the toast in to her tea.

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Child calling out and laughing: That's just like my sister.

The rest of the class seemed to know the sister.

Paul. (Reading)She took her false teeth out of the sugar and..

Child calling out: Did YOU make these up yourself?

Addressed to R. who ignored the interruption.

Paul. *Continued to read, smiling at interruptions,*
but keeping his place in the story. Would you like to go
to the castle?

The children were stopped to discuss the text in more detail, although the occasional interruption indicated that they were thinking about the text. The children were not corrected for their interruptions if they were spontaneous reactions to what was being read and did not stop the flow of the reading.

R. What do you think of Aunt Aggie?

Class. Various comments and laughing about putting her teeth in the sugar bowl.

Class. Rude.

R. What's wrong with that? It's her house.

Gordon. She puts me off sugar.

R. Well, there you are. Every time you went there you would be careful about taking sugar. You've got to check to see what's in it now....

Nora. Imagine putting your hand in to get a bit sugar and her false teeth were sitting on your hand...

R. She only put them in overnight. She took them out after breakfast, so you were all right for the rest of the day.

Nora. What if before she put them in she had a bit of fruitcake and you go to get a spoonful of sugar and there's bits of fruitcake?

R. Look at all that extra stuff you've got...

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Class. Discussion about Aunt Aggie's strange custom of keeping her false teeth in the sugar bowl. They were enjoying being disgusted and imagining incidents when they would want to use her sugar and find her teeth.

R. Could you read, please, Allan?

Allan. Read.... Scrambled eggs, beans and cabbage.

Class. What? Oh, no! Yuk!

R. What's wrong with scrambled eggs and beans and cabbage all on the same plate?

Class. Discussion of some menu disasters they had experienced.

Although the class seemed to be allowed to wander off the text, they were allowed to go no further than relating parts of the text to their own experiences. This type of story gave them the opportunity to compare the text with their every day lives, which were unlikely to be less organized than those of the characters in the stories. The end of this story introduced a new character that was put in to ensure that the children thought about the text instead of drifting into thoughts about Aunt Aggie, Edinburgh or cooking. It had been possible to predict that the children would respond to these subjects, but they could not be permitted to deviate from the goal of interpreting the text and considering an arithmetical question by drifting off into thoughts or subjects which appealed to them. Therefore, an old ghost suddenly appeared to introduce and pose the compare 6 arithmetical question:

'Do you live upstairs?' asked Jeremiah.

'No, I live here. Aggie has lived here for 89 years,' said the old man. 'She has lived here 243 years less than I have lived here. If you can tell me how long I've lived here, I'll introduce you to my friends.'

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R. Think about what it is that you need to know to find out how long the old man had lived in the house. Think about who has lived longer in the house.

It was important that the children appreciate the semantic structure of the text and to realize that the word 'less' was not to be used as an indicator that the sum was necessarily subtraction. At the end of the story, the arithmetical word problem was given to them in a conventional format:

Arithmetic question.

Aunt Aggie was a very old lady and had lived in the same house for all of her 89 years. She has lived in the house 243 years less than the old man. Grandma used to live in the house, but she moved out when she was 18 to go and live in Glasgow. How long has the old man lived in the house?

As the children started to scan the text of the question, they were directed towards the strategy for finding the answer. By stating that there were two parts with the necessary information, they were limited in their approach. Although the story was used to make them consider the details of the situation, the necessary information for the solution of the problem was within the text of the problem itself. By placing the problem first within the story then presenting it at the end, the language and mathematic domains were bridged because the children had learned the information in the language domain, but were asked to use it in the mathematical domain. They had discussed the meaning within the language domain, but were applying their understanding of the discussion within the mathematical domain.

R. What are the two parts that tell you what you need to know to find the answer?

Lisa? *Her expression had changed as though she had understood.*

Lisa. *Shrugged.*

R. What is the question asking you?

Lisa. To find the difference.

R. No, it's not to find the difference - that's not mentioned. What is the question asking you?

Lisa had assumed that the inclusion of the word 'less' in the arithmetical word problem had indicated a subtraction sum was required to solve the problem.

Lisa. How long the old man has lived in the house?

R. Right. How are you going to find out? *Children looked at text without much response. Where does it mention anything about the old man living in the house?*

Sally. It says that Aunt Aggie lived there for 89 years and that was 243 years less than the old manso he lived there for 243 more than the 89 years she lived there.

Sally had obviously understood the semantic structure of the text and appreciated that an easy way to find the answer was to add the 243 years to the 89 years that Aunt Aggie had lived in the house. Some children did not follow this explanation while those who did understand started the arithmetic question. If Sally had simply told them to add the two numbers together, this would have been transactional teaching and those children who followed her directions may not have understood why they were doing it. Her simple clarification of the semantic structure of the question gave some children sufficient guidance, or reminded them of a suitable approach, but did not give them more help than was required. Some children shared her insight into the meaning of the text

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either before or after she spoke and were able to proceed. Many started to do the sum immediately, so it is possible that they were waiting confirmation from another member of their social group that they were acting correctly rather than lacking in understanding themselves. The other children, who had not responded favourably to Sally's explanation, were given more help with the text.

R. That's fine. *Addressed to Tina and those children who were working on their own.* What about the 18 years that Grandma was living there?

Children scanned text without responding for about a minute.

Allen. Probably she did the cooking instead of Aunt Aggie. The question was not sufficiently lucid for some children.

That's a good answer.

This reply was to give a positive response to the child, but it was not the expected answer. However, it could be used to assess the child, and a few others who were looking confused, as requiring more specific help to respond to their needs. They had not understood the explanation offered by Sally, so it was necessary to go back a step and check if this were sufficient for them.

R. Does the 18 years have anything to do with the question, though?

Class. No. *Several voices.*

R. So that is a number which is there but which you do not need to pay attention to for the answer.

Some children may have been confused by all the numbers and assumed that they were all necessary for the arithmetical equation. They had to be instructed to ignore those that were not relevant to the solution.

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R. You have to keep thinking about Aunt Aggie and the old man. Look at that part.

This was to encourage the children to focus on the part of the text that was vital to the solution. After a quick visual check was made that the children were concentrating on the words, they could be helped to clarify their meaning.

R. So Aunt Aggie lived in the house for...Ralph?

This was a question directing them towards the necessary information and limiting them in their choice of information from the text.

Ralph. 89 years.

R. Do you remember what Sally told you about finding the answer?

The children were directed towards the ideal path set out by Sally and given the opportunity to complete the task on their own or receive more guidance if necessary. Most replied positively that the old man had lived in the house for 243 years longer so the two numbers had to be added. By taking them back to think about the meaning of the text a little more closely rather than consider how to fit the numbers into a sum, the children did the problem by themselves. Although the children had initially some difficulty with the semantic structure of the sentence that did not easily permit the formation of the correct arithmetical equation, (Stern 1993, Hegarty et al 1995,) the older ghost in the story helped them to formulate the equation. Similar stories and approaches were used for all the types of arithmetical questions.

RESULTS.

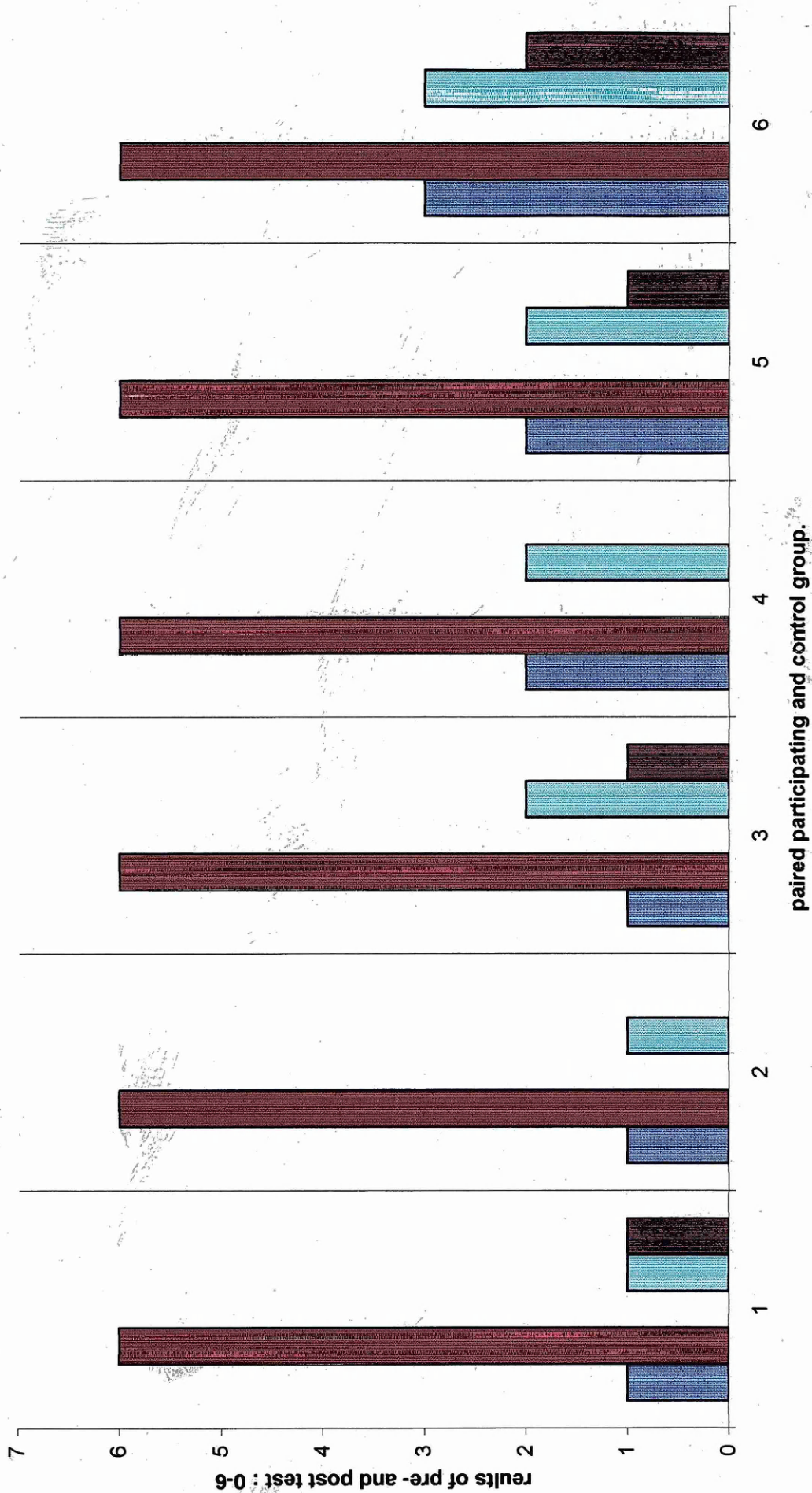
The purpose of the study was to discover if short stories that contained mathematics and were constructed to facilitate the use

of scaffolding techniques, improved the children's performance with arithmetical word problems. Therefore the assessment for the success of this approach was two fold:

1. A comparison of pre-and post-test results of all the children.
2. A consideration of the success of the stories to provide the opportunity for scaffolding.

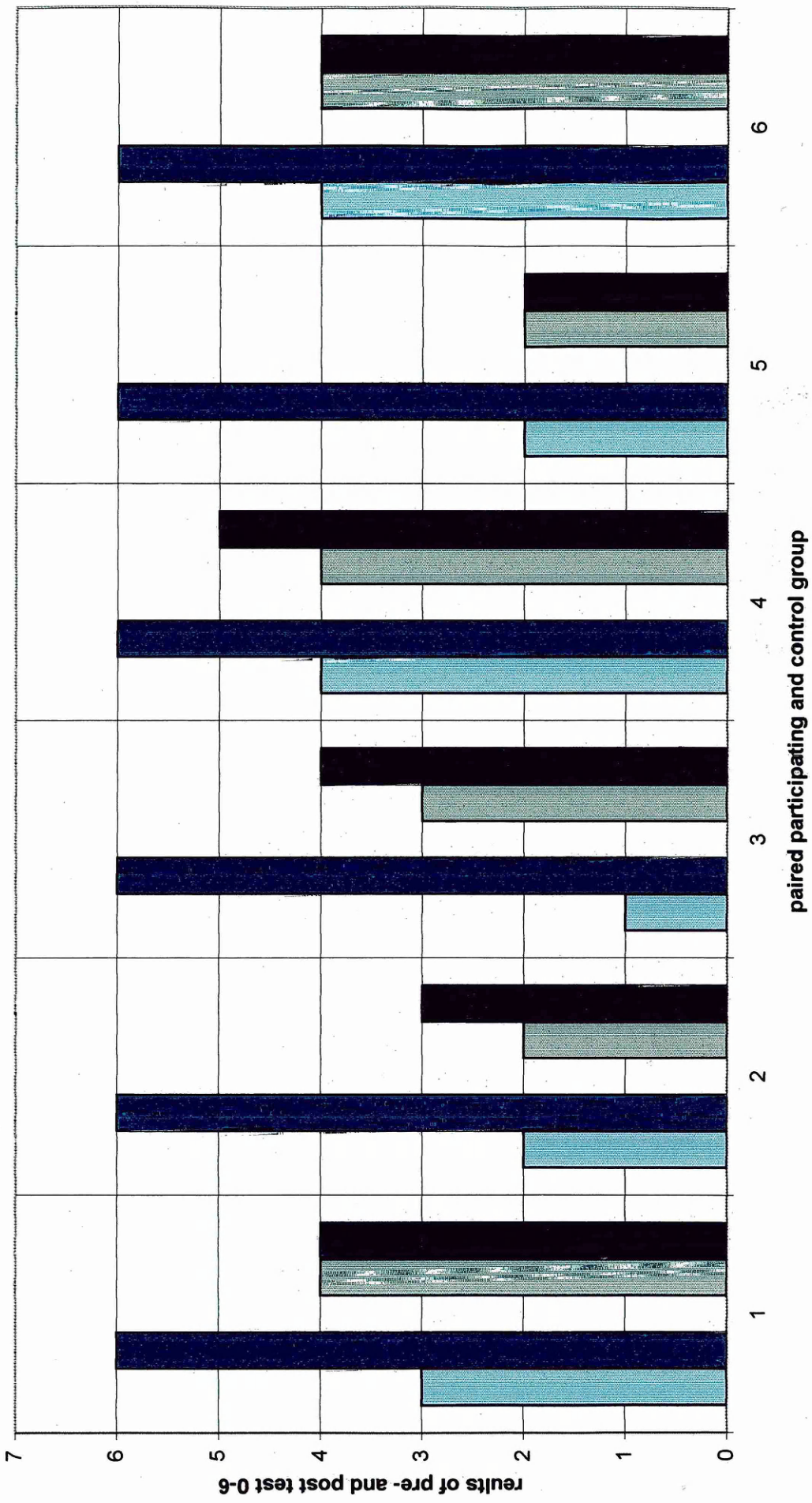
The control groups pre-and post-test were compared with those of the participating groups. The children in the participating groups had been matched as far as was possible with the children in the control group. That is, if for example, two children had difficulty with all the problems, one was placed in the control group and another in the participating group. Likewise, if two children had difficulty with, for example, the compare and change problems but no difficulty with the combine problems, one was placed in the control group and the other in the participating group. Where there was no identical match, but there was a necessity of including a child in the participating group to create a reasonable number for a study, the total number of correct and incorrect sums was compared. The pre-and post-tests of the class were compared and the results are recorded in the following graphs. The children were asked to do two sums each of combine, compare and change sums. If they had used the correct arithmetical equation, but had arrived at a wrong answer, they were considered to have the correct response to the task, because the purpose of the research was to help children with these word problems, not with their basic arithmetical skills. The graphs show the results of the participating child and their partner in the control group for Primaries 3, 4 and 6. The primary 6 class graph shows the pre-and post-test results. The children in the primary 3, 4 and 6 groups have lower marks than many in the primary 6 class because the children who had no difficulty with arithmetical word problems were not nominated by their class teachers to participate in the groups in this research. However, most of the children in the primary 6 class were permitted to participate by their parents.

Pre- and post -test results for Primary 3.



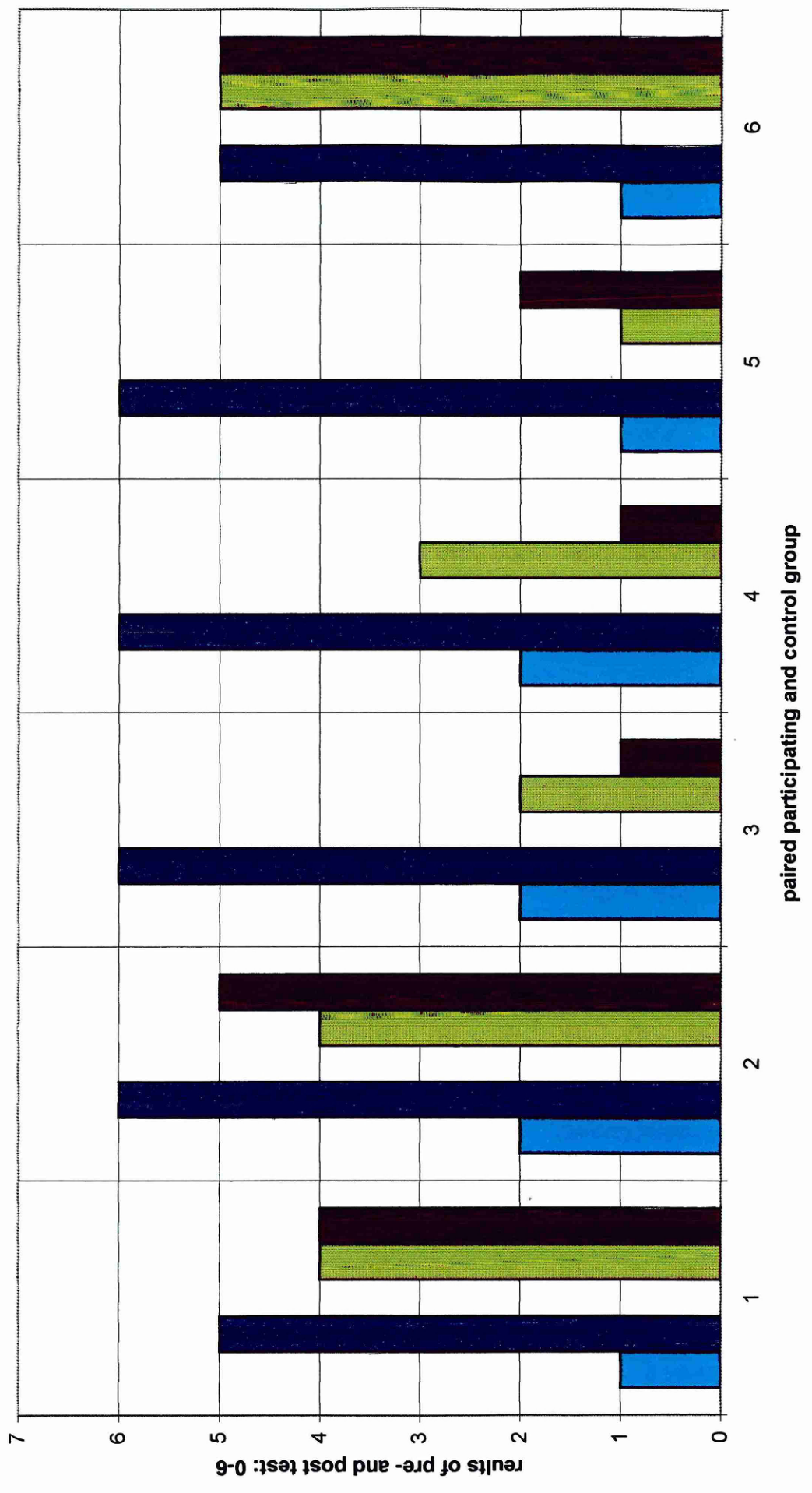
primary 4 pre-and post-test results.

Figure 7.2



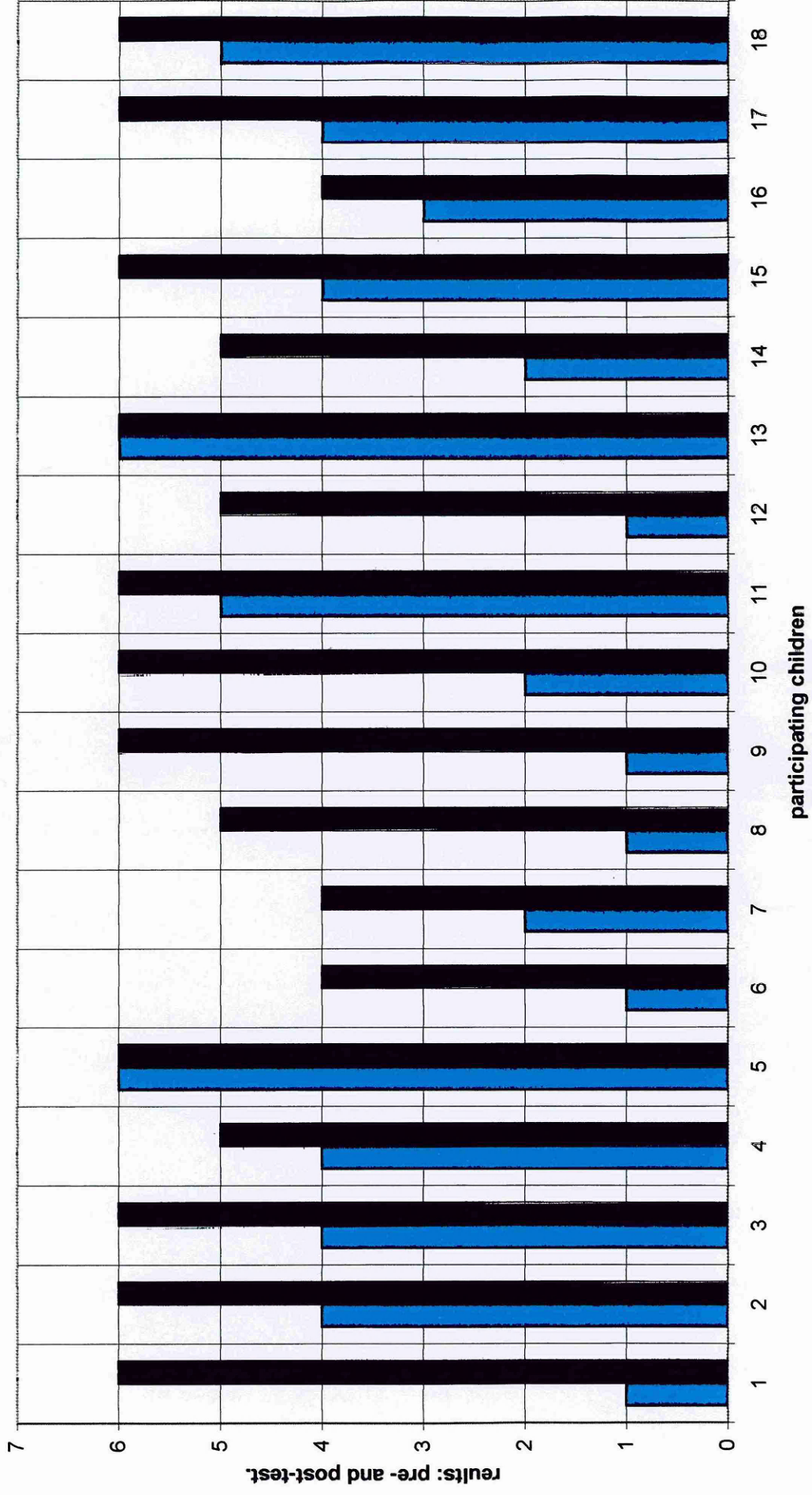
Primary 6 group pre- and post test results.

Figure 7.3



primary 6 class pre- and post-test results.

figure 7.4



It has already been discussed that research indicates that scaffolding is difficult to implement in schools (Bliss et al 1994). Teachers who are used to a directive approach find it difficult to implement, so it seemed reasonable to discover during the Main Study that pupils also become familiar with certain teaching approaches. Some children found it challenging to adapt to an unfamiliar teacher for a short time at the end of the day. Therefore, it was decided to concentrate on two aspects of the study that made use of scaffolding techniques:

1. Did scaffolding work?
2. Were the scaffolding techniques used appropriate to the method of preparation, presentation, subject matter of the Main Study and ages of the children?

This was to overcome the possibility of rejecting scaffolding techniques because of any inadequacy on the part of the teacher delivering the materials during the Main Study. Also, the nature of scaffolding implies that the instructor and learners are sensitive to one another, but this understanding of each other is unlikely to develop fully for all during the constraints experienced in the Main Study. At the start of the study, it was necessary to make a judgement based on a search of the literature on appropriate scaffolding techniques to be used in the language domain to assist the children in the interpretation of text. Although the following scaffolding techniques were the focus of this Main Study,³ the concept of scaffolding within the school situation is developing and it is possible that further research will indicate alternative scaffolding strategies. Scaffolding techniques may belong to an environment where the teacher and pupils are, at the least, familiar with one another. Although there was evidence of success with them in this study, there were missed opportunities too, which may not have occurred if adult and children had known each other better.

³ Appendix 1.

Figure 7.5 A Description of Scaffolding Strategies.

Description of scaffolding strategies used by teacher and peers for class, group or individual.	Primary 3 group.	Primary 4 group.	Primary 6 group.	Primary 6 class.
Reminding children of critical features of the task and scrutinizing the task (either for the pupils or asking them to do it).	30	12	14	37
Breaking the text up into short manageable segments for discussion and checking that the children understand each small section.	39	36	36	45
Encouraging the children to connect the texts to their own experiences.	31	16	16	26
Encouraging children to explain the meaning of the text in their own words and guiding towards a shared understanding of meaning of the texts.	28	12	17	17
Ascertaining that the children know what information is necessary for the formation of an arithmetical equation.	29	16	35	18
Checking that the children know what type of arithmetical process should be used.	24	8	14	19
Keeping the children on task.	10	9	26	28
Holding information for children who may be occupied with another aspect of the task	13	18	14	14
Guiding children to necessary part of text and focusing the children on specific strategies, i.e. using the text to formulate an accurate arithmetical equation	25	21	38	25
Check that children know how to solve the arithmetical word problem, perhaps by demonstrating idealized path.	4	11	7	5
Teach what the children do not know. e.g. Unifix bricks.	3	8	2	6
Check that the readers appreciate that each section of text relates to another. (In the Primary 6 class stories the information provided in one story was a necessary clue for a missing fact in another story).				26

There was a difference in the results of the learning groups and the control groups. The small group teaching may have affected the results of the groups to a certain degree, but the primary six class demonstrated improvements, so the use of the stories and scaffolding strategies must be acknowledged. The primary 3 and primary 6 class teachers decided to do arithmetical word problems from the mathematics textbooks with those children who were not participating in the study during the same period of the study. I requested that the children who were in the study should be given another activity and not be allowed to do the class word problems. The fact that five children's results remained static or decreased may be because they had been practising certain types of problems in their classrooms, but not the ones given in the post-test.

Chapter 8.

Conclusion.

Conclusion.

The results of the post-test compared with the pre-tests of participating children and the results of the control group indicate that teaching children to interpret text in the language domain assists them to interpret the texts of the arithmetical word questions with accuracy.¹ The different ages of the children was apparent in the responses during the teaching sessions, but they all responded very well to the materials that were compatible with their class work. Using scaffolding techniques in the language domain contributed to the development of interpretive skills. The scaffolding techniques used permitted a sharing of understanding and the opportunity to assess and help the learners while fading the help allowed the learners to use their interpretive skills. Frequent discussion of short sections of the texts emphasised any difference in meaning that may have occurred because of their varied experiences and helped them to come to a shared understanding. The participating children demonstrated by their responses their growing interpretive skills in the language domain and the results of the post-test showed that they had used this skill in the mathematical domain. Introducing mathematical words into the language domain permitted an explanation of their meaning within that domain using the characters of the stories to illustrate the meaning of these words before there was the need to form an arithmetical equation for the solution of the problem. The children, therefore, were not tempted to use only the numbers in the story to form the arithmetical equation because they were kept to the task of interpreting the meaning of the story.

The Primary three children were inclined to be distracted by an aspect of the story, or a statement made by another child and wander off the task while they were absorbing or thinking about this new information. It was necessary to hold the task for them until they had finished thinking about their new idea, then give it back to them by drawing them back to where they had digressed. They had to be taught to think about each aspect of the text and discuss its meaning not just to consider it a pleasant story. Their pace was slower than the older children in the study and they had to be given the time and

¹ Appendix 2.

encouragement to think about the text and relate it to their experiences. In the first teaching session, they were quite prepared to read the story and answer a few questions on it and it was difficult to persuade them to state an opinion. However, by the sixth story, they were discussing the text and scanning it for information if they considered a statement made by another group member to be inaccurate. The children from one of the classes needed considerable help with subtraction sums.

The Primary four children were encouraged to discuss the characters of the story. When they were asked to talk about the characters or small sections of text, they tended to assume the answer rather than use the text to ascertain the facts. They had to be taught to really interact with the text and think about the information given in it, and the difference between using their imagination and searching for the facts in the story. They discussed the arithmetical problems and assisted each other in the formation of the arithmetical equation.

The Primary six group were very talkative and discussed the texts with enthusiasm, relating the stories to their own experiences but they had to learn the difference between their opinions and the facts. The stories did not list facts about the characters but there was plenty of information given about them within the texts, so the children had to read the whole of the texts carefully. When they were asked to state their opinion about one of the characters in the story, they could not go to a specific section and find the answer because the information was revealed throughout the stories in little snippets. The children had many ideas about the texts and they had varying experiences in their own lives, which they discussed with one another and so contributed towards a shared understanding of the meaning of the texts. They spoke about the meaning of the mathematical words during the sessions and helped one another.

The primary six class had stories which were all connected through the characters. They not only had to look at the story they were reading to find information, but remember facts from previous stories to keep concentrating on the texts. In the first session, they had to be taught the difference between

their opinion and facts. There were many discussions about the meaning of ambiguous statements, but these were always clarified in later stories.

Teachers rarely consult academic journals, or indeed any type of publication that informs them of developments in research into children's learning, but they must take part in in-service development work. It would be interesting in the future to have the opportunity to continue this research with a group of teachers and explain the principles and theories behind the research to discover if this Study can be implemented in most classrooms and to expand the types of word problems. It was difficult to implement scaffolding techniques with a group of children who were unknown to me and, to some extent, to each other within the groups because each group came from two classes. A teacher with personal knowledge and a shared history of experiences with the children would have had less likelihood of missing scaffolding opportunities.

There were some aspects of the children's responses and needs, which had to be ignored because of the time factor, and these should be investigated to discover if they would have any impact on future outcomes. For instance, children with difficulties in basic arithmetic were not helped, nor were children who were poor decoders of the printed text. The arithmetical content of the word problems catered to children who considered competent but not good in arithmetic by their classroom teachers, so the standard was fairly low. In future, the study could be developed at an appropriate level for children who are better able to cope with the arithmetic of their year group. Different problems were given to each year group and the texts of the stories and of the arithmetical word problems were appropriate to the reading level of the participants, although it was decided to keep the types of stories and word problems similar for all the participants to permit a comparison of the results. Some of the children may have found factual texts more interesting and division and multiplication sums may have been more appropriate for older children, and this should be investigated in the future.

Although the stories which were written for the Main Study appealed to the children, in one sense, it may have been better if there had been input from a

professional writer. However, in another sense, the stories demonstrated that it is possible for any teacher to write stories that can be used to cross the domains from language to mathematics. In future, it would be an interesting exercise to use traditional stories and insert mathematical words into them, and check if the responses were as successful. For instance, in the story of Cinderella, it is possible to insert numbers at various parts of the text without losing the flow of the story:

- A specific number of mice could be changed into footmen.
- The prince could try the shoe on a certain number of ladies' feet in one village and a certain number more or less in another.
- The wedding guests could be counted.

Nevertheless, this research has demonstrated that it is possible for a teacher working either with a whole class or with a small group to improve children's success with arithmetical word problems through the use of a range of scaffolding strategies targeted at the language domain. The understanding developed is transferable to the mathematics domain within the context of these problems. The research has therefore demonstrated both the efficacy of scaffolding techniques and the transferability of the skills thereby developed across domains. While much work remains to be done, this is a significant first step.

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Appendix 1.

Scaffolding Techniques.

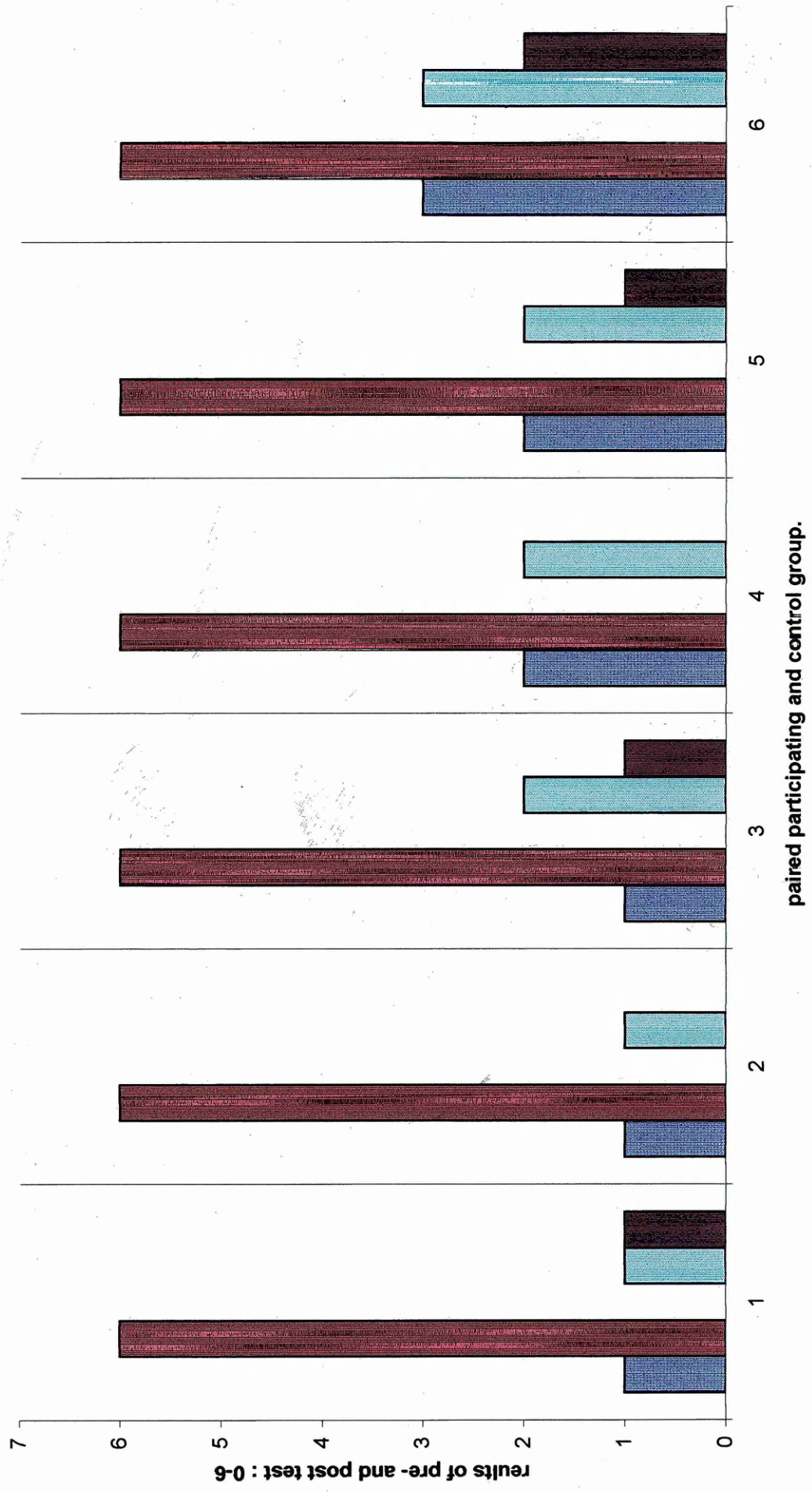
Appendix 1.

Description of scaffolding strategies used by teacher and peers for class, group or individual.	Primary 3 group.	Primary 4 group.	Primary 6 group.	Primary 6 class.
Reminding children of critical features of the task and scrutinizing the task (either for the pupils or asking them to do it).	30	12	14	37
Breaking the text up into short manageable segments for discussion and checking that the children understand each small section.	39	36	36	45
Encouraging the children to connect the texts to their own experiences.	31	16	16	26
Encouraging children to explain the meaning of the text in their own words and guiding towards a shared understanding of meaning of the texts.	28	12	17	17
Ascertaining that the children know what information is necessary for the formation of an arithmetical equation.	29	16	35	18
Checking that the children know what type of arithmetical process should be used.	24	8	14	19
Keeping the children on task.	10	9	26	28
Holding information for children who may be occupied with another aspect of the task	13	18	14	14
Guiding children to necessary part of text and focusing the children on specific strategies, i.e. using the text to formulate an accurate arithmetical equation	25	21	38	25
Check that children know how to solve the arithmetical word problem, perhaps by demonstrating idealized path.	4	11	7	5
Teach what the children do not know. e.g. Unifix bricks.	3	8	2	6
Check that the readers appreciate that each section of text relates to another. (In the Primary 6 class stories the information provided in one story was a necessary clue for a missing fact in another story).				26

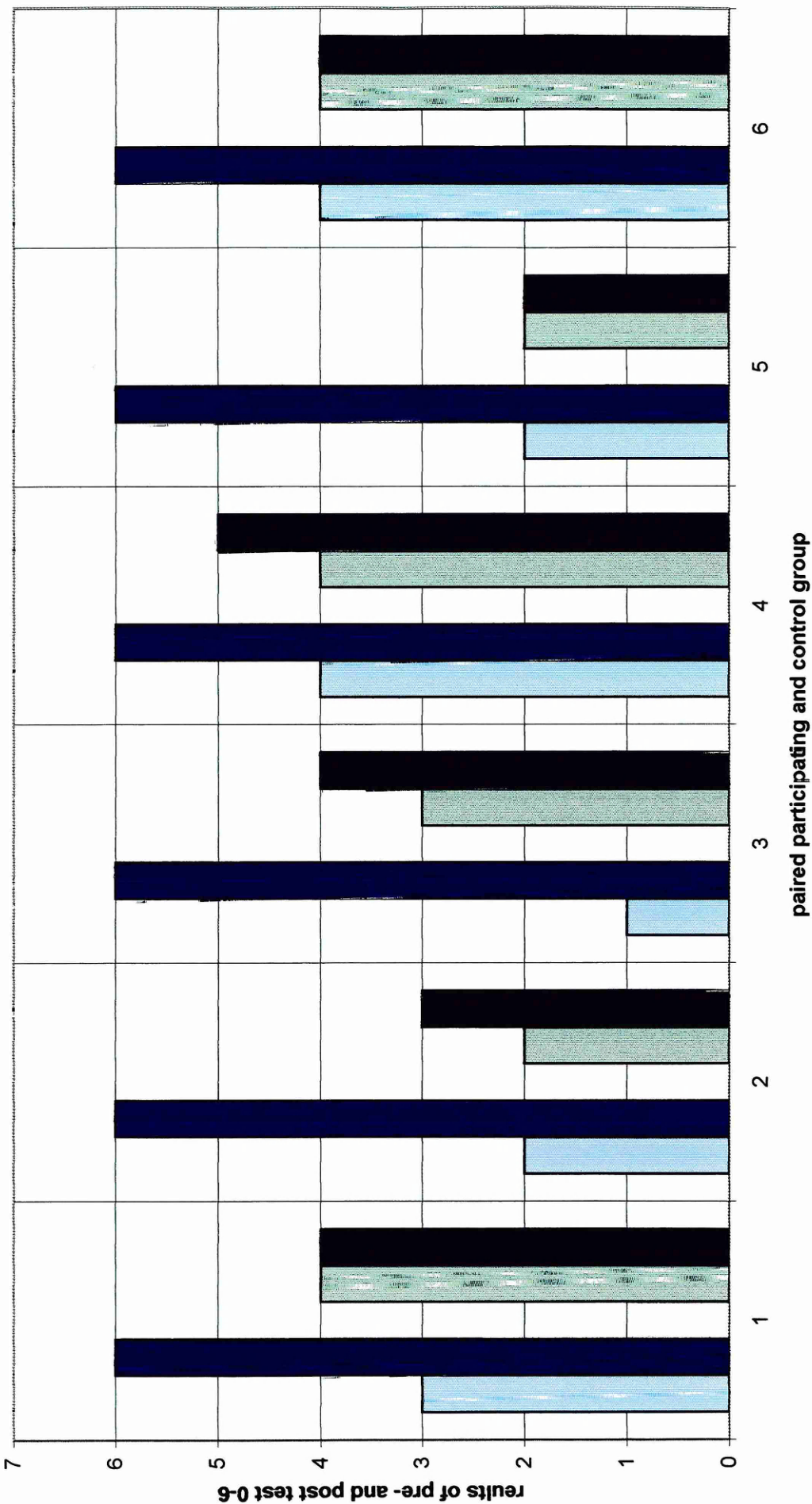
Appendix 2.

Pre- and post- test Results.

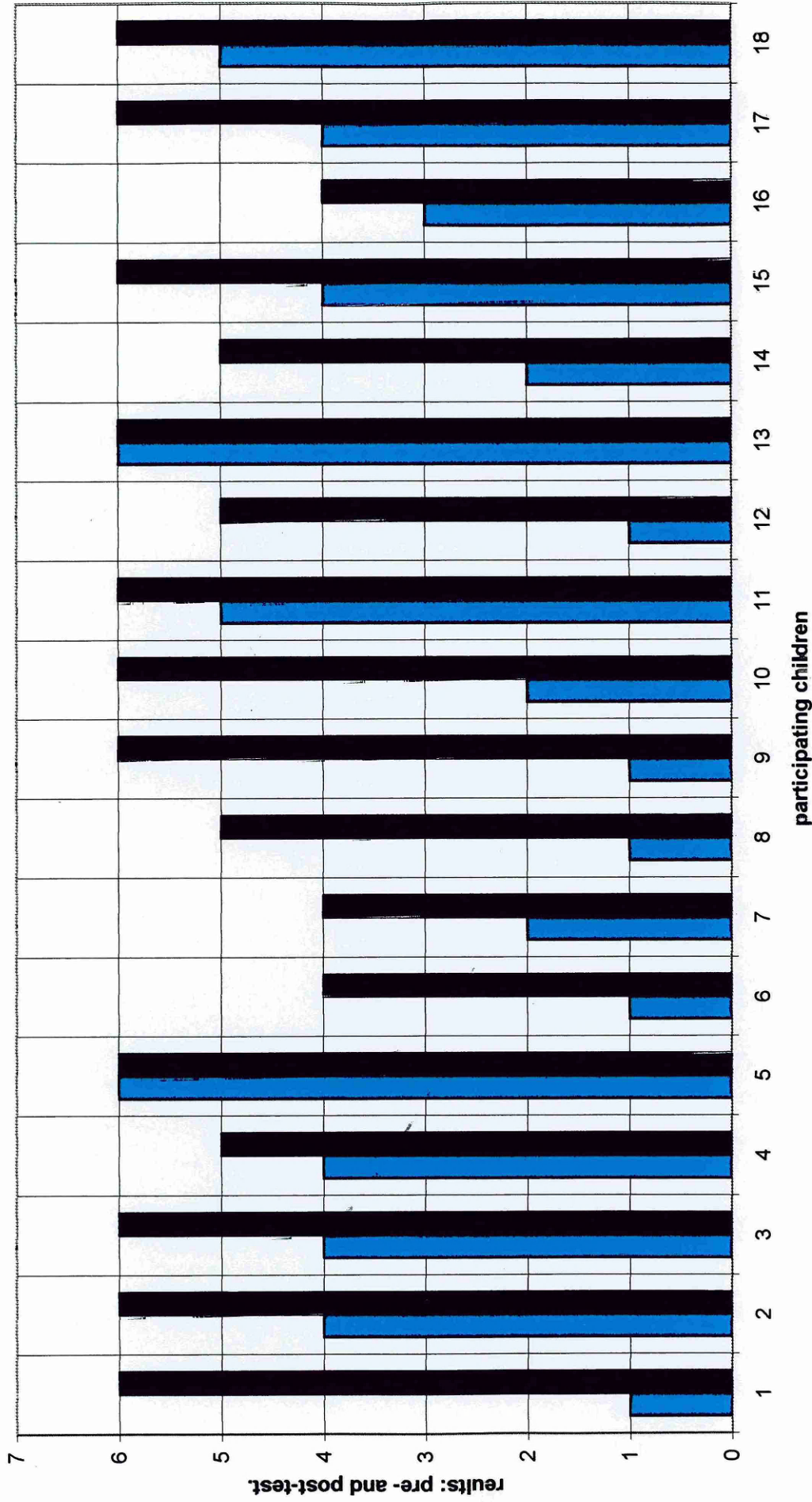
Pre- and post -test results for Primary 3.



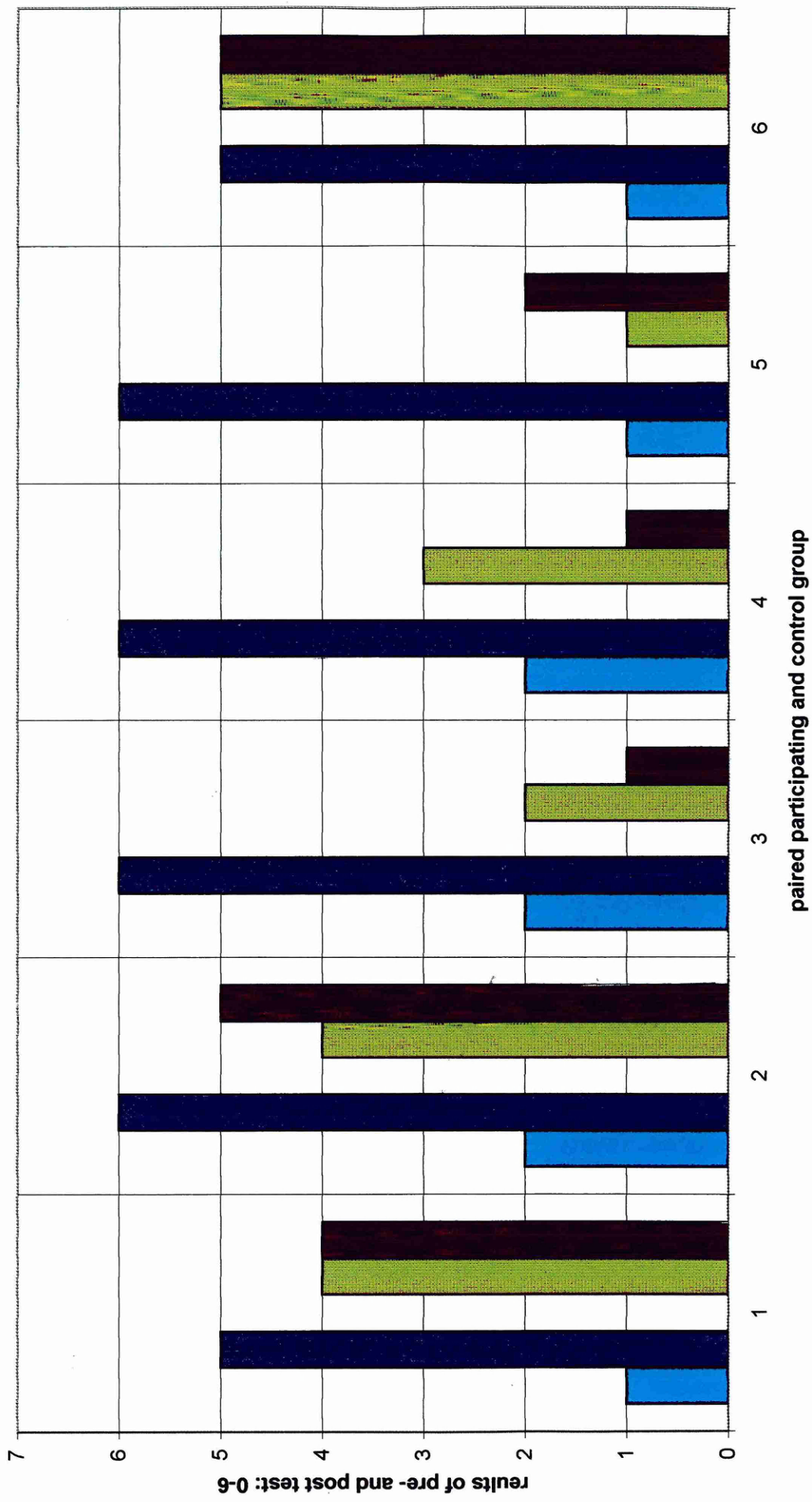
primary 4 pre-and post-test results.



primary 6 class pre- and post-test results.



Primary 6 group pre- and post test results.



Appendix 3.

The Stories.

A long walk

Cameron was a big school boy now that he was in Primary one, but Daniel was still in the nursery. Every morning Mum took Cameron to school, then she went to the nursery with Daniel. Every lunch time she went to the nursery and collected Daniel, then they both went to the school to meet Cameron. They all went home for lunch then went out to the park to feed the ducks and go for a walk with their dog, Poppy.

Today Cameron and Daniel had brought some of Grandma's currant cake to Amanda duck because she was their friend and came to say 'Quack, quack,' to them as soon as she saw them. It was cold because it was October and the leaves were starting to come off the trees. Cameron and Daniel were happy because they were both on holiday.

Cameron said to Mum,

'The teacher said I had to go to school all day after the holiday. Do I stay there until bedtime?'

'No!' said Mum. 'You finish about 3 o'clock.'

'Can I still come to the park every day to see Amanda?' he asked.

Mum explained, 'It will be winter soon and it gets dark early. It will be dark soon after you come out of school. I'll take Daniel to see Amanda during the week and you can see her on Saturdays and Sundays.'

'I don't like the winter,' moaned Cameron.

'Yes, you do!' said Mum. 'When it snows you build snowmen and throw snowballs and slide on the ice.'

'How will Amanda manage to find food in the cold?' asked Daniel.

'I'll ask the man who looks after all the ducks if I can give her any special food for the winter,' said Mum.

They walked past some very big trees where the squirrels played around and teased Poppy. The squirrels ran along the ground, then ran up the trees when they saw Poppy looking at them. She always chased after them, but never caught them.

Today the squirrels were gathering nuts in their little hands.

'Why are the squirrels taking all the nuts?' asked Daniel.

'Squirrels sleep most of the Winter, but they wake up some days if it is not too cold' explained Mum. 'They will put the nuts away in a safe place and eat them when they wake up. Why don't you help the squirrels to collect nuts for the Winter?' suggested Mum.

'Good idea!' said Cameron. 'I'll leave them on the ground near the tree so that the squirrels can find them.'

The boys dashed around gathering nuts into bundles for the squirrels to find. Daniel had little hands and he could not hold as many nuts as Cameron, but he tried very hard to help the squirrels. Mum helped as well.

When it was almost time to go home, they had three little bundles of nuts.

'Let's count them,' said Daniel.

Cameron said he knew he had 2 million. Mum said. 'That's wrong! Count them properly. Look. I have 69 nuts. I'll help Daniel to count his bundle of nuts.'

Cameron counted carefully before he said,

'I have 58 nuts.'

'Do you?' said Mum. 'That is 26 less than Daniel. Hurry up! Daddy will be home soon and we have to make the dinner.'

They rushed back past the duck pond and Amanda came hurrying over to see Poppy before they went away.

Think about Mum, Cameron and Daniel gathering the nuts to help the squirrels. Think about the numbers.

Arithmetic question.

Mum, Daniel and Cameron were gathering nuts in the park to help the squirrels find food for the Winter. Cameron found 58 nuts. He had 26 less than Daniel. Mum had 69 nuts. How many nuts did Daniel collect?

The Foxes.

Mr. Fox came out of his den at night and sniffed the air. It was Spring time. The flowers were starting to grow. His den was a hole deep in the ground in among trees in Knightswood park. All day he had waited for everyone to go home. Children had been playing in the park every day. Mr. Fox sniffed. 'Picnic time again,' he said. He could smell the bits the children had dropped. He liked chocolate and crisps.

Mr. and Mrs. Fox did not have time for playing. The twins, Ginger and Rusty, seemed to eat and eat and eat. Mr. and Mrs. Fox took it in turns to stay at home to look after the twins or to go out to find food. The twins stayed in the den and waited for their Mum or Dad to bring the food to them. Tonight Dad was going out. Near the den he found crisps in a bag and took them in to give to his family.

'More crisps?' said his wife. 'Time for proper food!' she said.

'I'm going now,' said Mr. Fox. 'Be good children when I am out,' he said to the cubs. 'See you soon with lots of lovely food!'

Primary 3

'Bring me fish and chips, please,' said Rusty.

'Pizza for me! Pizza for me!' shouted Ginger.

'Have you forgotten the magic word?' Dad said to Ginger.

'Please,' said Ginger.

Dad went out. Then he came back into the den again.

'It's a lovely night,' he said to Mum. 'Will we all go out tonight?'

'Outside? With you? Oh yes! Yes! Yes! Yes!' shouted Ginger.

Andrew is going on holiday.

Andrew, Greg and Tara were going on a summer holiday with lots of their relatives. They were going to the sea side. Andrew was sad. Grandad and Grandma were staying at home to look after the houses and the dogs. He wished they could come too, but Grandma and the dogs did not like sitting in the car for a long time. For days Andrew asked his Grandad to come, but he said,

'No, I want to stay at home.'

He asked his Mummy if he could stay with Grandad, but Mummy said, 'No. Grandad wants to stay at home and he wants you to go on holiday.'

Mummy said,

'You can send Grandad a postcard from your holiday.'

Andrew went to his bank and took out his money. He counted it and said to his Mum,

'I've got 38p left in my bank. Will that be enough to buy a postcard?'

'No, a stamp costs 27p,' said Mum. 'Ask Greg if he will give you some money put of his bank.'

Greg was happy to give Andrew the money for a postcard for Grandad. He emptied all the money in his bank into Andrew's hand. Andrew counted it carefully.

'Now we have 72p altogether,' he said. 'I had 38p and the rest is yours. That is enough to buy a postcard for Grandad.'

Greg said he wanted to buy a postcard with 5 dolphins on it just like the one his cousin had sent him from Canada.

The arithmetical question.

Andrew wanted to send his Grandad a postcard when he went on holiday. He took his money out of his bank.

Andrew had 38p in his bank. It was not enough to buy a postcard. Greg gave him money. Now he has 72p. How much did Greg give him?

Primary 3.

Andrew's Gran and Grandad.

Andrew's Mum and Dad were out all day working, so Andrew and his brother Greg went to their Gran and Grandad's house after school. Gran looked after their baby sister all day. Every day after school, Greg sat down and told Gran all about what he had done in school and the baby sat and smiled. This was the time Andrew liked best. He had Grandad all to himself.

On Thursdays Grandad said, 'Come on, Andrew. I've got to go to the supermarket to buy a cake. My sister is coming to visit.' So Andrew and Grandad walked to the supermarket and looked at everything in the shop. Andrew always got the cake he liked for his Great Aunt. He knew she liked the raisins inside it.

If it was sunny, Grandad worked in the garden. Andrew had a wheelbarrow. He always said, 'I'll take the weeds up to the bin for you Grandad. Put them in the wheelbarrow.'

So Grandad put the weeds into Andrew's wheelbarrow and Andrew wheeled the weeds up to the bin for Grandad. Grandma liked flowers in the garden. She said to Andrew, 'I have some packets of flower seeds. Will you help Greg to plant them?' Andrew made little holes. Greg put the seeds in them. Andrew put soil on top of the seeds. Then Greg forgot about them. Grandad said, 'We must look after Grandma's flowers.' So Andre watered the seeds with his watering can. They grew into flowers for Grandma. Grandad said, 'You are a wonderful gardener, Andrew.'

On Mondays and Fridays they all went into the car and went to the library. Gran looked at books with Greg and the baby ad got some books for herself. Grandad always said to Andrew, 'Come on! Let's find some books you can read. Andrew could read by himself. Mum and Dad had to read to Greg and the baby. They always took lots of books home. Grandad, Grandma took 20 books out

Primary 3.

altogether, but only 6 of them belonged to Andrew because he could not take out as many as the grown ups. Andrew liked it best when Grandad had his paints out. Grandad was good at drawing and painting. Andrew said, 'Can I draw, Grandad?' Grandad said, 'You can with my magic paints.' So he gave Andrew paper and paints and said I'll show you some painting tricks. He showed Andrew how to draw people, animals, houses, flowers and trees. Andrew told his friends that he had the best Grandad in the world.

The park

'Come on, Poppy. I'll not let the duck catch you,' Daniel told his dog as they went into the park gates. Daniel and his big brother, Cameron, were taking their dog, Poppy, for a walk in the park. They were walking round the duck pond, throwing in crusts of bread as they went along. They went to the duck pond most days after school to feed the ducks. Sometimes they had bits of cake as well and the ducks dived down after it. They loved the currants and cherries in the cake. Poppy wanted her share of the cake and Cameron always gave her a little bit.

Poppy, the dog was afraid of the ducks. Every time they quacked, she wanted to run away. She was sure they were going to come out and flap their wings in her face. When she was a very small puppy, a swan had hissed angrily at her and now she was afraid of everything that swam around in ponds.

Amanda Duck loved to scare her. 'There comes that big black and white dog again,' she said. 'I'll chase her away and eat the bread and cake all by myself.'

So Amanda swam to the edge of the pond quack, quack, quacking at the top of her very loud duck voice. Cameron threw the bread far out into the pond to keep Amanda away from his dog, Poppy, but Amanda enjoyed frightening her. Cameron threw the bread and Daniel stood with his arms around Poppy's neck, rubbing her ears and saying,

'Don't be afraid, Poppy. Amanda is just playing with you and won't peck you.'

One day Amanda did not come to catch the bread and the boys looked all over for her. She was on her nest on a little island in the middle of the pond and she had just laid eight eggs. She was sitting on them to keep them warm. Cameron threw the bread as far as he could manage and Amanda waddled off the nest, down into the water, ate the bread and went back to sit on her eggs again.

A few weeks later, Amanda was waiting for them to come with her bread. Her chicks had hatched and she wanted to show them to the boys and the big dog. She wanted to teach her ducklings to quack at dogs. She paddled to the edge of the pond with all her chicks following behind her. Poppy wagged her tail when she saw all the tiny ducklings. She was not afraid of them.

Suddenly a big brown dog jumped into the pond near the ducklings. Amanda was afraid that the dog would hurt her ducklings. She quacked and flapped her wings at the big dog. It just barked at her. The boys shouted at the big brown dog to leave the ducklings alone. Poppy growled at the big brown dog and jumped into the water and chased it away from

the ducklings. Amanda quacked at the top of her very loud voice and Poppy chased the dog right out of the water and out of the park gates. Poppy walked back to Amanda and the ducklings. Amanda quacked at her, and Poppy knew that she was saying, 'Thank you.' Every day after that Poppy went to have a look at the ducklings and Amanda brought them out of the water to let her give them a friendly lick. They quacked quietly at her and eat some cake crumbs. Poppy took some crusts, but she always ate less than Amanda.

The Foxes.

Mr. and Mrs. Fox of Knightswood went out every night looking for food. They took their children Ginger and Rusty with them. Sometimes they found fish and chips in paper outside the fish and chip shop. Sometimes they found bits of pizza in boxes at the bus stop. Sometimes they found chicken bones in the bins at the houses.

One night Mr. Fox said to Ginger and Rusty and Mrs. Fox,

"I know where we will always find food. Follow me!"

They ran quickly along the big road. There were lots of cars but they hid in the dark when a car came. Suddenly Mr. Fox stopped at a very big house.

"What is that lovely smell?" asked Ginger.

"A school," said Mrs. Fox. "All schools smell like that."

"What is a school?" Rusty asked his Dad.

Mr. Fox knew everything. "Children go in there and eat all day," he said.

"Come and look at these bins!" said Mrs. Fox.

Six giant bins sat outside the school.

"Plenty for everyone!" said Mr. Fox.

He climbed into a bin and dropped a plastic bag down to the children. They put their noses in and pulled out caramel pudding, sausage rolls, potatoes, carrots, lamb curry, pink custard, lettuce and chicken. They ate and ate and ate. They could not eat any more.

"I want to go home now," said Ginger. "I'm tired."

"I am still hungry," said Mrs. Fox. "Let's play a game. Who can find the most sandwich crusts?"

Ginger and Rusty started looking for sandwich crusts. There were lots as many children in the school did not eat them. They collected lots of crusts and started counting them.

'I'm tired. Want to go home,' said Ginger.

'Keep counting,' said Dad. 'Your Mum is hungry and she has found lots of lovely sausages.'

Primary 3.

'We've no more crusts to count,' said Rusty.

Dad dashed away and came back with more crusts.

'That will keep you busy for a few more minutes,' he said.

The fox cubs counted the crusts Dad gave them.

'Thank you for the 16 crusts, Dad,' shouted Rusty. 'We've got 24 crusts now and 12 of them are from crusty bread and the rest are from plain bread.'

'How many did we have before Dad brought us some?' asked Ginger.

'I'm not sure. I'll have to think about that,' said Rusty. He sat down to start counting but he fell asleep and started to dream about a school for foxes where fox cubs ate all night until the sun came up.

'Wake up, you two,' shouted Mum. 'Time to go home.'

Think about the crusts. What are you told about them? How many were there?

Arithmetic question.

Dad gave the cubs 16 crusts. The cubs counted and had 24 crusts with 12 crusts from crusty bread and the rest from plain bread. They counted all the crusts. They had 24. How many had the fox cubs collected by themselves?

The visit.

Emma and Holly were feeling miserable. Mum and Dad had bought a new house and they were all going to move. Their new house was really a very old house. The wallpaper was horrible and the carpets were ugly. Nothing in the kitchen worked very well. The workmen were going to be fixing everything for weeks, so Mum said that the girls were going to stay with her Aunt Mary during the summer holidays. They were not happy about this.

'We've never stayed with Aunt Mary before,' they said. 'She always comes to see us. How do we know that she lives in a proper house?'

'We know,' said Mum and Dad, 'We've been there and you two are going to stay with her for a month.'

'Does she know what little girls eat?' Emma asked. 'Does she know that little girls don't eat vegetables?'

'Little girls who don't eat vegetables can sit in the baby's pram all day and drink milk,' said Dad.

So Emma and Holly put their favourite books and toys in a bag and waited for Aunt Mary to come. When they saw Aunt Mary spinning round the corner in her little green car, they said goodbye to the baby, the rabbit and the old house.

She grabbed their bags, threw them into the car boot and told the girls to sit in the back seat as the dog always sat in the front. The dog was big and red and hairy with a very waggy tail. The girls were very quiet in the car. The journey seemed to go on for ever.

Suddenly the car swung into the drive of an old house.

'Out, quick!' said Aunt Mary. 'I'm hungry!'

She hurried them into the house and took them up to their bedroom.

'Just find your own way around the rest of the house,' she said. 'Don't touch the computer until I show you how it works. Then remember not to use the Internet until after six o'clock and only when I am with you. Those are my rules.'

The girls waited for her to remind them about teeth brushing, finishing their food and everything they had to do at home, but she did not say another word.

'Dinner in half an hour. Look around. Play with the dog. Watch children's television. Read. Do whatever you want,' she said as she disappeared into the kitchen.

Emma and Holly wondered what dinner was going to be as they looked around the house a little afraid to touch anything.

'It's ready now,' Aunt Mary shouted. 'I hope you like hot food.'

The girls soon discovered that 'hot' did not mean 'warm'.

'Look out for the chillies! I was going to take them out but I couldn't see them in the pot.' Aunt Mary warned them. 'If we can't travel round the world, at least we can try the food.'

After dinner Aunt Mary said that she was going to send e-mails to some relatives and friends. If they wanted to, they could come and help. So they went up to the computer and read e-mails from relatives who lived far away, then sent their answers. The girls loved hearing about everyone.

'Look at the time!' Aunt Mary exclaimed.

Emma asked, 'Is it bed-time already?'

'Hurry up!' said Aunt Mary. 'I want to run over to the Supermarket before it closes. You two had better come.'

Off they all went to the supermarket even though the girls were sure it was past their bed-time. Aunt Mary grabbed a trolley.

'Throw in anything interesting,' she ordered as she tossed in a pineapple, two mangoes and a star fruit.

That is how the girls learned to enjoy food from all over the world.

Most mornings they all took the dog out for a walk. Sometimes they took her to the local park and played in the children's playground when the dog was playing with her doggy friends. Other days they all crowded into the car and took her to the seaside or into the country and up hills. They went to the museum to see the Egyptian mummies and famous paintings. Another day they saw very old cars, buses and tram cars in a huge building. On a cold windy morning they went to the Botanic Gardens and saw bananas growing and many beautiful flowers from all over the world.

Sometimes Aunt Mary came off the phone and shouted, 'Quick! Visitors! Tidy up!' and the three of them dashed around hoovering and dusting. Sometimes Mum and Dad came to see them with the baby, Julia. They said they had both grown. Sometimes Mum's Aunts, Uncles and cousins came and the children all ran around the house up and down stairs and in and out of all the rooms.

Aunt Mary was different from any grown-up the girls had ever known. She cooked amazing meals, sent them to bed when they looked tired, took them out every day to see or do interesting things, told them stories about her brother, their Grandad, when he was a boy and helped them to send e-mails to all their relatives all over the world.

One day Mum came and said,

'The house is ready now. Time to go home and back to school.'

'I'll miss you two,' said Aunt Mary. 'You must come back and visit me soon.'

The trip to the ocean.

Maegan lives in Canada. It is very cold in the winter and there is lots of snow. Maegan loves the snow and she is a very good skier. She can skate better than Grandad. Every time he tries to skate, he falls on his back. He is a good skier, but he is no good at skating and Maegan laughs and laughs at him.

Although Maegan enjoys playing in the snow, she does not miss it when it melts in the Spring because she knows that Spring is sailing time. Every year Grandma and Grandad pack lots of food, warm clothes and some school books into the big van and set off to Grandad's boat which he keeps far away on the coast.

As soon as the snow starts to melt, Maegan says,

'Are we going to the ocean tomorrow?'

'Not yet,' says Grandma.

'Soon,' says Grandad.

Then one day, Maegan sees that Grandma and Grandpa have everything ready to be put in the van and she cannot sleep with excitement. She knows they will be leaving in the morning. She will miss the rest of her pets and her Mum but she is happy to be going on the trip.

She says, 'I'll phone you every night, Mum, to tell you about my holiday. Look after all my friends for me, please.'

So Grandma, Grandpa, Maegan and one of the dogs called Maji, set off on their long journey. Maegan thinks they have just left her house when Grandad says,

'What about a tea break?' and they have to stop to make a cup of tea.

Sometimes he stops to take photographs so that Maegan can show her Mum what she saw when she was on holiday. Sometimes the dog, Maji wants out for a run and they have to stop for her.

Grandma says, 'Too many stops! It will be time for us to go home before we arrive at the ocean.'

So Grandad hurries on for a little while and after two days driving and two nights sleeping they arrive at the ocean.

Maegan loves swimming in the water and sailing in Grandad's boat. The boat is called the Leprechaun. On very windy days it seems to leap and jump around in the water just like a real Irish leprechaun.

Then Grandma says, 'I'm not going in that boat today!'

but Maegan and her Grandad do not mind the waves. They put on their lifejackets and set off out into the ocean. Grandma goes to the shops to buy food and presents.

The next day was lovely and sunny and they were all on the boat. They had just set off out into the ocean when they saw seals swimming around and

basking in the sun on the rocks and on the shore. Maegan tried to count them but they kept moving around and flopping into the water. Suddenly the wind blew and the boat started moving faster..

When Grandad and Maegan were putting the sails up and Grandma was busy fixing the picnic lunch, the dog started barking at something in the water.

'Look! Dolphins!' shouted Grandad. They all ran to the side of the boat to watch the dolphins playing in the water. The dolphins saw Maegan and they leaped and turned over and around in the air. They made strange little noises as they did this. Maegan loved their happy faces. They looked as though they were smiling.

There were lots of them swimming around. Maegan wished she could go in the water to swim with them, but Grandad said the water was too deep for her. She told Mum about the dolphins when she phoned her that night.

She said, 'I saw lots of seals and dolphins today.'

Mum said, 'Did you count them?'

'I couldn't. They kept swimming around,' said Maegan, 'but I think there were less dolphins than seals.'

The holiday in Ireland.

Greg was on holiday in Ireland with his Mum and Dad, his big brother Andrew, his little sister Tara and his dog, Sophie. Many of his cousins, his aunts and uncles and his Mum's cousins were on holiday with them. They were staying in a house near the sea. There was a garden outside the house. Outside the garden was a field with a horse. Greg loved all animals and he loved watching the horse.

'Greg! Time for bed!' shouted Mum. Greg did not want to go to bed. He was in the garden with Sophie and the horse had come to see them. Greg wanted to give the horse some sugar lumps and the horse wanted Greg's sugar lumps.

'Coming in a minute, Mum,' he said.

'Now!' said Mum.

Suddenly Sophie ran into the field after something. Greg jumped into the field shouting, 'Come here, Sophie.' The dog barked and barked. She was barking at the smallest man Greg had ever seen. He was smaller than his baby sister.

'Stop barking! Do you want to tell everyone I'm here?' he said angrily to Sophie.

He looked at Greg. 'Who are you? Why are you staring at me? Have you never seen a leprechaun before?'

'No,' replied Greg, 'I haven't. Are there leprechauns in Scotland?'

'There may be some,' said the little man. 'All leprechauns live in Ireland but sometimes we go to Scotland or England or all the way to France to watch the rugby. I like the big ferries. I went to Scotland a long, long time ago with the giant Finn McCool in a small boat. He was seasick. Have you ever seen a sick giant?'

'I have never seen any kind of giant,' said Greg. 'My friend says my Mum is a giant, but she isn't really,' said Greg. 'She isn't as big as Grandad and he isn't a giant.'

'No, your Mum isn't a giant,' said the leprechaun. 'I've seen her putting out the washing and she is tall, but not a giant.'

Greg was happy to hear this and he smiled at the leprechaun. Then he thought about the rugby,

'I wish I was a leprechaun. I like watching rugby on television but Mum and Dad won't take me to see a match.'

The leprechaun smiled at him and Greg noticed that the dog was wagging her tail and a little bird was sitting on the leprechaun's hat and a mouse was peeping out of his jacket pocket.

'I really wish I was a leprechaun,' said Greg. 'Small animals like you.'

'You want to be a leprechaun?' The little man was very surprised. 'Most children want to be a giant. You are the first one I have met who wants to be small.'

'I want to be a vet when I grow up and look after animals,' explained Greg.

Suddenly he saw that the leprechaun's shoe lace was not tied.

'Will I tie your shoe lace for you?' he asked politely.

'Yes, thank you,' said the leprechaun and he put his foot out to have his long lace tied.

Greg was not very good at tying laces, but he did it in the end.

'Thank you. That was very kind of you. There are no rugby matches on in the summer, so I cannot take you to one, but if you want to ride the horse I will have a word in his ear and he will let you get up on his back every day of the holiday.'

'Oh, thank you,' said Greg. 'I would love that. I have sugar lumps to give to him before I go to bed.'

He held out his hand to show them to the leprechaun. The leprechaun took something out of his pocket.

'Take these 5 lumps of sugar,' he said. 'That will make 8 altogether.'

'Bye,' said the leprechaun and he just disappeared as Greg's Mum came out for him.

'I saw a leprechaun,' said Greg.

'Did you fall asleep out here?' Mum said.

Greg was going to say that he really had seen a leprechaun but Mum was laughing at him so he said nothing.

He thought 'She will see me tomorrow on the horse and know that the leprechaun worked his magic.'

Primary 4

Name:

You know the story about Finn McCool and the Scottish giant, but did you know about Finn's friend the leprechaun? Do you know that leprechauns are clever little Irish elves who have lots of gold?

Finn McCool sat in his Irish castle and the Scottish giant sat in his Scottish castle counting their bags of gold every day. A little leprechaun sat beside Finn McCool helping him to count his gold coins because Finn was not good at his sums.

One day Finn's wife said,

"Go over to Scotland to find out how much gold the giant over there has in his castle."

Finn started to build a path a path from Ireland to Scotland. At the same time the Scottish giant's wife said,

"Don't sit in here all day counting your gold. Go over to Ireland to see Finn McCool."

The Scottish giant started to build a path from Scotland to Ireland. When Finn McCool saw the very big Scottish giant coming across the path, he was very frightened and dressed up as a baby. The Scottish giant ran away when he saw the baby because he thought that it was Finn's baby. He thought Finn McCool must be enormous to have such a big baby. He ran back to Scotland and pulled up the path as he ran and threw the rocks into the sea.

This annoyed the leprechaun because he wanted to know how much gold the Scottish giant had in his castle. He said to himself,

"I know Finn McCool has 95 bags of gold because I count them every day. How can I find out how much gold the Scottish giant has in his castle?"

He said to Finn,

"I want to go to Scotland to see the Scottish giant."

Finn McCool said,

"I will take you in a boat to Scotland, but I will not go to the Scottish giant's castle. He's enormous and I'm afraid of him."

So they set off in a boat and soon reached Scotland. Finn sat on the beach and made a giant sand castle and the leprechaun went to visit the Scottish giant.

"How much gold do you have?" he asked the Scottish giant.

"How much gold does Finn McCool have?" said the Scottish giant.

"45 bags," said the leprechaun

"Bring me his gold and I will share it with you," said the Scottish giant slyly.

Primary 4

Name:

"I will have 89 bags if you bring Finn McCool's gold. I will give you 13 of them," promised the Scottish giant.

So the leprechaun went away to find Finn and to tell him how much gold the Scottish giant had in his castle.

Arithmetic question.

The Irish giant, Finn McCool, had 45 bags of gold. If the leprechaun gave the Scottish giant Finn's gold, the Scottish giant would have 89 bags of gold. How many bags of gold does the Scottish giant have in his castle?

Maegan.

Maegan lives in Canada with her Mum, her Gran, her Grandad and lots of pets. Sometimes it is very cold where she lives and she can skate and ski. In the Spring the snow melts and the flowers start to grow again. It is time to help Gran and Grandad in the garden. Every year Gran and Grandad grow beans, lettuce and tomatoes and lots of flowers.

'Come on, Maegan, I'll take you to the gardening shop to buy some seeds for your garden,' said Mum.

'MY garden? I thought it was Grandad's garden,' said Maegan.

'Yes, it is. But he says you can have a little bit to grow your own favourite vegetables and flowers,' explained Grandma.

'But I like all the vegetables Grandad grows,' said Maegan.

'Then you can have a vegetable growing competition,' suggested Grandma.

'What does that mean?' asked Maegan.

'Just grow the vegetables and I'll explain when they come up,' said Grandma.

Mum and Maegan went down to the gardening shop. Maegan chose a packet of dwarf beans, curly lettuce seeds, tomato seeds, turnip seeds, sunflower seeds and marigold seeds. Mum loved tomatoes, so she bought a packet of giant tomatoes seeds and said she would grow them.

Mum said, 'Enough! Grandad is giving you a little bit of the garden, not all of it.'

Maegan looked after her garden every day after school and at weekends. Grandad helped her dig it. Then he showed her how to plant the seeds.

Every day when she came in from school, she looked to see if they had grown. One day her Mum said,

'Do I see something green in your garden?'

Some of the seeds had started to grow. Maegan looked after them carefully. She watered them when it was sunny and pulled out the weeds when it was wet.

In a few weeks some of the plants were taller than Maegan. She looked at the label. It said 'Sunflowers.' They were very tall flowers. The beans were growing high and she had to put in sticks to hold them up. The tomatoes were growing little baby tomatoes.

'I looked at all my tomato plants and I counted all my tomatoes this morning. I have 134 tomatoes growing. How many tomatoes are on your plants, Mum?

'There are 12 on each plant and 8 plants are growing well, so that makes 96 tomatoes,' said Mum.

Primary 4.

'What about Grandad's tomatoes?' asked Maegan. 'Do you know how many he has growing?'

'Yes. You have 23 tomatoes less than Grandad. I have just counted them,' replied Mum.

Maegan was looking forward to eating the tomatoes with the lettuce. She knew Grandma would cook the beans and turnip for her when they were ready. Perhaps she would make turnip soup if they grew big enough. Maybe one would grow so big, everyone would have to help to pull it out of the ground.

Think about all the vegetables. What are you told about them? How many turnips? How many beans? How many tomatoes? Who grew them?

Arithmetic question.

Maegan, Mum and Grandad grew vegetables and flowers in the garden. Maegan counted 134 tomatoes growing on her plants. Mum said that she had 8 plants growing well with 12 tomatoes on each plant and that made 96 tomatoes. Maegan had 23 tomatoes less than Grandad. How many tomatoes did Grandad grow?

The weekend visit.

Emma, Holly and Julia were visiting their Aunt Mary for the weekend. Their parents had gone to a wedding and no children had been invited, so Aunt Mary had taken them to her house for the weekend.

When they arrived at Aunt Mary's, the baby was fed quickly and put to bed. Then Aunt Mary and the girls looked in the freezer. She always had meals ready for visitors to give her more time to talk to them.

'I'll have the mince and make some pasta to go with it,' said Aunt Mary.

'That sounds good,' said Emma, 'I'll have the same.'

Holly was about to say that she did not like mince when she remembered that Aunt Mary's mince was different from any she had ever tasted anywhere else.

'Did you put in tomatoes, onions and kidney beans?' she asked.

'Yes! And many herbs to give it flavour and some chillies to make your tummy warm,' replied Aunt Mary.

'I'll have some too, please,' said Holly.

They put the tub of mince in the microwave and put some pasta in a pot of boiling water. It was soon ready, then eaten, so they took some banana bread just in case there were empty spaces in their tummies.

They could not go out in the car, or go shopping to the supermarket because Julia was sleeping upstairs, so Aunt Mary said,

'Will you help me to sort out some of my photographs, please? I have some of your Mum when she was a little girl.'

'Oh, yes. We would like that!' they both said.

Aunt Mary disappeared into the cupboard under the stair. First she walked in, then she bent over, then she knelt down and crawled along the floor as she pulled out boxes and boxes full of photographs from the very back of the cupboard under the stair.

'Try to carry them into the sitting room. If the boxes are too heavy just drag them along the carpet,' she suggested.

They all sat on the floor and looked at all the photographs.

'Who are all these people?' wondered Emma.

Holly said, 'Why are they wearing such strange clothes?' as she looked at a very old photograph.

'They are your Grandad's Grandmother and Grandfather,' explained Aunt Mary. They are your great great grandparents. They lived a long time ago before there were computers.'

'How did they manage to write letters?' enquired Emma.

'Pen and paper! Many people still use that way of writing,' Aunt Mary reminded them.

Aunt Mary gave them a bundle of photographs and said,

'There are photographs of your Mum, your Aunt Nicola and your Grandad in there somewhere.'

They soon had them picked out and Aunt Mary said,

'Would you like to keep them? I have too many old photographs.'

'We have some at home,' said the girls, 'but we would love to have some more.'

Aunt Mary counted out 27 photographs of their family. There were 9 photographs of Grandad when he was a boy, 4 of his wedding to Grandma and 14 of their Mum and Aunt Nicola as children, and told them to keep them safe and put them in a photograph album when they got home.

The girls stayed with Aunt Mary until Sunday night when she took them back to their house in her car. They took a long time to unpack everything they had collected and it was almost their bed time when they finished. They just had time to put the photographs in the album. Mum came in to say 'Goodnight.'

'I put Aunt Mary's photographs in the album and now we have 43 photographs,' said Emma sleepily.

'How many did you have before aunt Mary gave you some?' said Mum.

No one answered. The girls were all sleeping.

When they came in from school on Monday, Mum said

'Remember to phone Aunt Mary later after you have done your homework and thank her for looking after you at the weekend. Don't forget to tell her you put all the photographs in the album. How many do you have now?'

Think about the photographs and what you are told about them. Think carefully about how many Aunt Mary gave the girls. Perhaps you could draw a picture to help you think about this story.

Arithmetical question.

Aunt Mary gave the girls 27 photographs of their family. There were 9 photographs of Grandad when he was a boy, 4 of his wedding to Grandma and 14 of their Mum and Aunt Nicola as children, and told them to keep them safe and put them in a photograph album when they got home. Emma and Holly put them in the photograph album then told their Mum that they had 43 photographs in the album. How many did they have before Aunt Mary gave them some?

Normandy.

It was the summer holidays and the annual three week family gathering had been arranged for all the relatives. Every year Rachael and her brothers had been taken on holiday by their parents, but their holidays were always different from the ones which the travel agents arranged. This year they were in Normandy where Aunt Geraldine had rented a very large house which held everyone. All four grandparents were there with all the aunts, uncles and cousins. The relatives came from Edinburgh, Glasgow, the Scottish borders, the south of England and Italy. There had been the usual difficulty packing everything and everyone into the cars, but eventually they had set off with Stefan saying every five minutes,

'How far now, Mum?'

'600 miles.' replied Mum.

'What's that in kilometres?' asked Rachael.

'Too far!' said Dad.

At every stop some of the children wanted to try another car and sometimes this caused difficulty when four of them wanted to squeeze onto three seats.

'This is worse than organizing an expedition up the Orinoco!' Grandad muttered.

Everyone wondered how he knew that because he spent most of his spare time playing golf.

'Where's the Orinoco?' said Stefan.

'You'll know soon enough,' muttered Grandma. 'You and your Grandad will both be going there soon if you don't keep quiet!'

The children were sleeping when they crossed on the ferry to France, then they spent hours the next day driving around the countryside having picnics and looking at places which the grown-ups said they would find interesting. They looked at the places where many people had been killed during the war and Rachael shivered because she was sure there would be ghosts around.

It had been very dark when they had arrived at the house as it had taken them some time to find the correct road to the house, even though Geraldine had carefully written out the instructions for them and marked the route out on maps.

'This is the wrong place!' said Grandad as soon as he saw the house. 'We never paid for anything as grand as this!'

'Maybe Aunt Geraldine won the lottery and this is her present to us,' suggested Rachael.

Primary 6

Grandma's feet were sore. 'Don't look a gift horse in the mouth. Just find the beds and get into them. They can throw us all out in the morning if we're wrong.'

Grandma was always telling them not to look a gift horse in the mouth. None of the children were sure what it meant, but Grandad said it was her way of telling them not to criticise a present. Rachael went to bed wondering about what would happen the next day when they were evicted, but the bed was comfortable and she did not worry for too long.

The next morning Rachael took her little cousin Victoria out into the garden to play. It was huge and there were beautiful flowers, rows of vegetables and some parts which were quite wild and full of large stones. Victoria lived in a small house in Windsor in the south of England and loved to run wild in big gardens.

When they went back to the house for something to eat, the grown-ups were talking about the holiday house.

'Well I can't see anything wrong with the place. Maybe the neighbours are not very friendly..... I can't think why they rented out this huge place so cheaply,' Grandma was saying to Aunt Geraldine.

'The house is wonderful and there is nothing to worry about. Just enjoy the holiday. This is the first time we have had so much space,' advised Aunt Geraldine. So Grandma wandered off to a quiet, cool corner of the garden with her books, sun hat and lounge.

The days passed with everyone having fun. Each day the children ran off to the wild part of the garden to play. Matthew always collected some strawberries to eat and his big cousin, James usually gave him some more so that he had enough to give to his Uncle Richard from Italy who was chef for the first week. Rachael was the eldest grandchild and felt responsible for her younger brothers and cousins. Her brothers said she was bossy but Mum said she was sensible and kept them out of trouble. So when Matthew and Victoria started to try to move a very large stone she told them to leave it alone before they hurt themselves.

'Won't stop. I can do what I want. You can't make me stop,' Victoria screeched.

'Drop it before it lands on your toe,' shouted Rachael.

Her brothers started to chant, 'Bossy Rachael! Bossy Rachael!'

'Do as you are told this instant!' commanded a loud Irish voice. 'Rachael is trying to keep you out of trouble!'

Rachael recognised the accent from her last holiday in Ireland. The smaller children stared at the stranger and Rachael turned round to discover a lady wearing an unusual long dress with her brown hair braided in colourful ribbons down her back.

'Clear off you little nuisances and leave my house alone. I don't want to see you back over my doorstep until you have learned manners and good behaviour.'

Victoria's voice quivered as she asked 'Where will we sleep tonight?'

The Irish woman stared at her. 'What are you talking about? You never sleep in my house. You just disturb my peace during the day then run away before the sun sets. Now be off with you!'

'Sorry,' said Rachael. 'I didn't know anyone lived here. Do you put up a tent at night?'

'A tent! Why would I sleep in a tent when I have a house with solid stone walls?'

Suddenly Rachael realised she was talking to a ghost. Her Uncle Michael would love to meet this woman. He was writing a family history going back for hundreds of years and he had told her that her great, great - about thirty greats - grandmother from Ireland had married a very important soldier from Normandy and had moved to France to live in his house. There was a story written about them and it could still be read in a big book in Dublin Castle.

Rachael was a very polite girl and introduced herself to the stranger. She explained that she was on holiday with her family. The lady smiled and said, 'I have not told you my name yet; it is Catherine.' Then she explained that her second name was a little difficult to say so she spelt it out for Rachael.

'That's my Grandad's name!' exclaimed Rachael.

The spaceship.

It was 3999. Richard was on board the spaceship Pioneer 57. His family had volunteered to join the expedition that would explore some planets identified as being habitable by previous excursions. The crew of the other spacecrafts had studied the atmosphere, vegetation and water content of the planets. Now the people on board Pioneer 57 would construct living pods, leisure places and learning areas for the settlers who would come from Earth.

There were many families on board Pioneer 57, but Richard's was one of the largest family groups. He had three great grandparents, four grandparents, great aunts and uncles and their families, both parents, his father's two brothers and sister, his mother's sister and his own twin sister, Mary all travelling with him. Everyone had different work to do on the spaceship and it was important that families who joined the crew had a variety of skills or could be responsible for one particular part of the spaceship. Most of Richard's family was responsible for the computers that were used for communication on board the ship and with other ships, Earth and the settled planets. His Aunt Geraldine was a translator for Earth language and a few other New Worlds languages. His great Grandmother, his aunt and three of his uncles were Earth lawyers and they used the communication computers to work for many people on other spaceships and planets.

Richard was 10 earth years old. He had spent his entire life on board spaceships or on the planets that his family was preparing for settlers. Richard preferred the Pioneer spaceships to the Adventure Spaceships, even though there were less people on board. Sometimes he had a holiday on Earth with his parents, or they visited a relative who had decided to live on one of the planets. While he was on the spaceship, he went to the learning rooms every day where his Great Aunt Jacqueline was one of the teachers. Aunt Geraldine spent a little time each day teaching them languages.

For his tenth birthday, Great Grandma had given him a very unusual present. At the start of the second Millennium, Michael, one of his ancestors, had written out a family history going back to the first Millennium. Since then someone in each generation had taken responsibility for recording and updating the information. Richard was fascinated by the different lifestyles of his ancestors. The first ones Michael had written about were a knight from Normandy and his Irish wife. Michael said he had met her once when he was on holiday in France, but she was a ghost by then. Richard wished he could meet some of his ancestors.

The Move.

It was the start of the summer term in school and Marie Claire had wonderful news for her Mother. She had been given a very important part in the school's summer play. She dashed up the stairs to the flat where she lived with her Mother, rang the bell impatiently and started talking as soon as her Mother opened the door.

'Miss Martin sent for me today and said....' Then she noticed the tell-tale signs of a move to another house.

'Are we moving again?' she asked crossly. 'Do I have to change schools this time?'

Ever since her parents had separated, Marie Claire and her Mother had moved house several times. Her Mother had always given her good reasons for the moves. First they had gone to live near some of her Mother's relatives. Then her Mother had found a teaching job, so they moved near the school. When her Mother had saved some money, they moved to a better house.

'Where is it this time?' she asked suspiciously, alarmed by her Mother's silence.

'We're going to move into your Grandma's house. She needs someone to look after her and she will always be in when you come home from school at night,' her Mother explained.

'But the play! I want to be in the play!' she exclaimed.

'We must move soon,' replied her Mother. 'When you went to see your Dad a few weeks ago, I went for an interview for a job in a school near your Grandma and the letter came today to say I got it. They want me there in a fortnight, so we may as well go now and settle in Grandma's house. You can start school before me and tell me what it is like.'

'What do you mean? You aren't going to be my teacher?' Marie Claire would hate to have her Mother watching her doing all her work; or not doing it sometimes.

'Maybe next year, but this year I will be teaching the infants.'

Marie Claire stomped off into her room. She was miserable. They were going to stay with a Grandmother she had seen only once AND have her Mother teach in the school. She knew there was no point in arguing, so she packed once again. She should have known her Mother was planning something because, when the television had broken down on Sunday, she just said,

'We'll buy one in a couple of weeks. You can spend more time reading till then. You don't read as much as I did at your age'

The next morning they both went to school to tell the head teacher that Marie Claire was leaving. One week later they were in the car heading

towards Grandma's house. They had sold all the furniture as there was no room for it in Grandma's house. Everything belonging to them was in the car.

On the way her Mother spoke to Marie Claire about her Grandmother and the house.

'She's a keen gardener, you know. She grows vegetables and beautiful flowers.'

'I thought we were moving because she need looking after,' said Marie Claire in surprise.

'She does!' said her Mother. 'She is getting old and forgets to cook proper meals or do the housework. She prefers to work in the garden and does not have a television. Her house is really too big for her, but she won't move. It is where her parents lived.'

Grandma opened the door as soon as they arrived and said to Marie Claire,

'Let me have a good look at you! You look exactly like your Mother when she was a little girl.'

After they had something to eat they started unpacking. Marie Claire's room was a big one in the attic at the top of the house. She could see for miles around, but it was time for her favourite television programme and she wished she could watch it. Her Mum came puffing up the stairs, but Grandma said she only went up there if it was really necessary.

'Do you like your room?' Mum asked.

'It's all right. I don't like the wallpaper or the carpet and I wish we had a television,' Marie Claire answered.

'Grandma has just suggested that, as there are seven rooms in the house altogether, we can have three all to ourselves and she will keep the others. We can buy new carpets and decorate them the way we like them. the first thing we must do is go out and buy a television,' explained Mum.

The Normandy Holiday.

Rachael was on holiday in Normandy in France with her family and many of her relatives. She realised that the lady who was talking to her in the garden of the house where they were staying was a ghost. She was not in the least bit afraid of her, especially when she discovered that the lady had the same name as her Grandad. Her Uncle Michael had told her that her Great, great, about 20 great grandmother had gone to live in France and now Rachael knew that this ghost was her relative.

'You look exactly like my Aunt Jacqueline,' she said to the lady. 'I think you must be related to me because you have the same name as my Grandad and I know someone in his family went from Ireland to marry a French soldier hundreds of years ago.'

'Please introduce me to the rest of your family,' said the ghost.

'I'll bring them to you if you wait a minute,' suggested Rachael.

'I have waited hundreds of years,' replied the ghost. 'I can wait for a few minutes to meet my relatives.'

Rachael dashed off to gather all the family and bring them out to the garden to meet the ghost. Some were a little afraid to come, Uncle Michael grabbed his notebook and pencil, Grandma tidied her hair and Grandad ran all the way to have a look.

'Good afternoon,' he said. 'My name is Richard. May I introduce you to the rest of your family? Or do you know them already?'

'My name is Catherine,' said the ghost. 'I am sure I know most of them by now, but some have never come to my house to let me see them properly and I do not go out much these days.' She smiled as she was told all their names. 'How strange! Many of the names are the same as my children and grandchildren. Thank you all for coming to meet me. I have met some of my relatives in the past because the family lived here for hundreds of years. Now that I have met all 38 of you who are here on holiday, I know 479 relatives. I would love to meet the 63 relatives Richard has been telling me about who did not come with you.'

Every day of the holidays the family visited their ancestor, Catherine, and learned all about her life so long ago. They were very sad when they had to leave her, but she told them to come back next year for a holiday.

'I'll make sure no one else wants to stay on my land,' she said. 'I will just walk around my gardens looking at the visitors and they will soon go away. Perhaps some of you will stay here for ever some day.'

Think about the relatives. Think about how many Richard introduced to her.

Arithmetic question.

Catherine said, 'Now that I have met all 38 of you who are here on holiday, I know 479 relatives. I would love to meet the 63 relatives Richard has been telling me about who did not come with you.'

How many relatives had Catherine met before Rachael and her family came on holiday?

The cousins.

Marie Claire lived with her Mum and her Grandma in her Grandma's old house. At first she had not liked it at all because she had to move far away from all her friends and her Mum was teaching at her new school. The house was miles from anywhere interesting and Gran had got it cheap because no one else wanted to live in it. Then she helped Mum decorate the rooms Grandma said they could have for themselves and she liked her house a little better even though it seemed to be falling apart. Eventually she made friends at school and took part in many school activities, so she started to enjoy school again.

'Good news,' said Mum one night after she had been talking on the phone. Marie Claire was not so sure about the good news. Her Mum had thought telling her about the move to Gran's house was good news, and her job teaching in the school was good news and being allowed to decorate their rooms was good news. Marie Claire was sad because she had to leave her friends, hated having her Mum around the school and was tired with all the painting and decorating in her Gran's messy house.

'How good was the news going to be?' she wondered.

'Aunt Anne is coming for a visit with her three girls, Emma, Holly and Julia,' said Mum.

'Wonderful!' said Gran.

'Why?' said Marie Claire.

She found her cousins annoying as Emma and Holly were always arguing with each other and she could never talk to them about anything without one of them starting a disagreement with the other. Julia was still a baby, so she could not talk yet.

'Where are they going to sleep?' she asked suspiciously.

'Don't worry,' said Mum. 'We'll tidy up one of the rooms Grandma never uses and they can stay there.'

They all arrived by train when Marie Claire and her Mum were at school one Friday and they stayed for the next week because it was a holiday. Marie Claire was surprised to find that the girls did not argue so much when they were visiting Grandma. She kept them all busy working in her garden.

'Come and I'll show you how to take cuttings from plants,' she said one day.

Another day she taught them how to prune the roses, 'They will just grow wild if you don't look after them properly.'

They all enjoyed working in the garden, although Marie Claire sometimes wondered what it would be like to go shopping in town like her friends, or go and see a film. Grandma did not approve of such pastimes and Mum said

they all cost too much money. Eventually they all became interested in the plants and how some plants flavoured food and how some could make you feel better if you were not well.

'Remember we are going home tomorrow,' Aunt Anne said to Emma and Holly when she heard the girls talking about growing tomato plants outside.

'What will we do with our new little plants?' asked Holly. 'I have taken cuttings of some of Grandma's nice smelling plants and I want to take them home and put in Grandpa's garden.'

'I'll help you to wrap them in wet newspaper and put them in a box. They will be safe until you put them in the garden at home,' offered Marie Claire.

Holly and Emma gathered all their cuttings and plants and Grandma gave them 6 bags of vegetables and 204 apples. Marie Claire was surprised to discover that they had gathered 526 little plants and she was beginning to be sorry that she had offered to help.

'Where did these all come from?' she asked Emma.

'From all over Grandma's garden,' she replied. 'I gathered 371 and the rest are Holly's,' she said.

'Then why is Holly not helping?' Marie Claire shouted as she saw Holly running off and leaving them both to do all the work. Now she knew why Emma was always arguing with her.

Arithmetic question.

Marie Claire was surprised to discover that Holly and Emma were taking home 526 cuttings and plants, 6 bags of vegetables and 204 apples. She was beginning to be sorry that she had offered to help pack them, especially when Holly ran off without helping.

'Where did these all come from?' she asked Emma.

'From all over Grandma's garden,' she replied. 'I gathered 371 and the rest are Holly's,' she said.

How many are Holly's?

Jeremiah's family.

Jeremiah was walking along the road, dragging his heels and school bag along the pavement. It was the first day of term and he did not want to go to school, but he was happy to be out of the house. Since Dad had lost his job, Mum expected him to do all the housework, cooking, washing and ironing while she was at work and he took his new role as houseperson just too seriously in Jeremiah's opinion.

When they both worked, they did not notice the mess in Jeremiah's room. They just told him to keep his own room tidy - no one else had time to do it. When they both worked, he had gone with his sister, Anna, to his Grandad's flat after school, eaten his dinner there, done his homework and waited for his Mum or Dad to phone. All he had to do was go with his Grandad and Anna in the lift down to his own floor in the block of high flats where they lived.

Now that Dad was out of a job, he collected Jeremiah and Anna from school and made them change and do their homework as soon as they got home. He noticed things like the mess under Jeremiah's bed. Dad called it 'disgusting!' but Jeremiah thought it was a very interesting collection. There were old crisp bags which may be worth a fortune one day, broken games which he kept for spare parts, some biscuit crumbs which would be good for a pet mouse, if he ever got one and a plastic bag with some photographs in it. When he started school, his Grandma had always taken him to see her favourite football team and he had collected the programmes. His Grandad found 642 programmes in an old box at the back of a cupboard and gave them to Jeremiah. Now he had 921 programmes which he kept under his bed for safety.

Jeremiah loved his school holidays. He spent his time playing with his friends and doing his own 'scientific' experiments. Although he was a keen footballer, he had more enthusiasm than skill and only played when his friends needed him on the team. He really enjoyed cycling and racing some of his classmates through the park on his bike. His Dad had taught him how to look after his bike, the best kind of tyres to put on it and how to use all the gears properly. His Dad had worked in a garage and Jeremiah hoped to work with cars when he was a grown up.

His other hobby was what he called 'chemistry'. Before she had left, his Grandma had told him about different plants and how some were good for magic. He was sure that if he tried long and hard and chopped up enough of the correct plants, he would find some wonderful magic potion which would make him the best footballer in the school, tidy his room at the snap of his fingers, turn his Dad's cooking into something tasty or, at least, keep the teacher in a very good mood.

On the last day of the school holiday, he was going into his flat when he heard his Grandad say, 'She's back from wherever she's been! That means trouble for all of us. No peace! We'll have to watch everything we do and say or who knows what will happen?

'Is Grandma back home?' shouted Jeremiah.

'Yes,' said Grandad, Mum and Dad in the same miserable voice.

Grandma was different. Jeremiah had noticed when he was very small that when someone annoyed her, she never really said anything to them. She just flicked her fingers in a strange little way and something always happened. Sometimes they sneezed for about five minutes. Sometimes they rolled over on to their backs and just kept turning round in circles and rolling around for ages. When the teacher told Jeremiah's Gran that Jeremiah's writing was neat and tidy, Gran was so pleased that she flicked her fingers at the whole class and they all floated and flew around the classroom.

'Gran! Gran! You're back!' shouted Jeremiah as he ran up to Grandad's flat without waiting for the lift.

'Where have you been? I've missed you!' he said as he ran in and almost knocked her over.

'I had to go on a sort of shopping trip far away,' she replied. 'You are a big boy now and it's time I taught you a few things. Every day after school you must come into the kitchen and learn how to cook a few spells.'

Jeremiah was surprised. He was amazed. He was horrified to think that his Grandma was a witch and she was trying to turn him into a wizard. He could not believe that Grandma was a witch, but only witches knew about spells and real magic. He ran out of the door, away down to his own flat to tell his Mum. She was not surprised. She said,

'I'm a witch. Anna is a witch, but she is too young to be trusted with magic. Everyone in my family are witches or wizards, but we use our magic powers only for the good of others. Listen to Grandma. She will teach you many wonderful things.'

The Yellow Stuff.

Since Anna's and Jeremiah's Gran had come home, life had been very peaceful. Gran sent Dad out for job interviews and she and Grandad tidied the flats when everyone was out. She rushed around the place dusting and Hoovering, making the beds and washing the dishes. When they were finished, they jumped on to their motor bike and went out. They always came back to collect the children from school but never said where they had been or what they had been doing.

'Don't ask them!' said Mum. She knew her Mother and Father liked to meet up with all their friends.

'Who cares where they are?' said Dad. 'I'm glad that your Mother keeps away from me.' He hated it when Gran waved her fingers in his direction - especially when she made him spin round until he was dizzy or turn him a strange colour. Once he had said that all the players in her favourite football team were useless and she made his hands turn the same colour as the team's strip. He felt silly fixing cars with gloves on but she would not change them back until he promised to buy her a season ticket.

One day, when they were collecting the children at home time, they noticed that Anna did not have her lunch box. Jeremiah said,

'Wait a minute and I'll run back into school and find it for her.'

He looked everywhere. The teacher looked all over the classroom and the janitor searched around the school. It could not be found anywhere and Anna could not explain what had happened to it. The next day she came home with her hair all messy and said she did not know how she had lost her hair clips, even though she had spent ages in the shop choosing them. The day after that she came home with her reading book in a plastic bag the teacher had given to her. When Jeremiah said,

'Where did you put your new school bag? It cost a lot of money!'

Anna just started crying.

Gran looked thoughtful and said,

'Just leave her alone. There's nothing wrong with a plastic bag. Tomorrow I'll go and thank the teacher for giving it to her.'

The next morning all three set off for school; the children looking smart in their school uniforms and Gran, wearing her biker leathers, looked a little different from the other grown ups. The children went to class and Gran asked to see Anna's teacher. Anna saw them talking together for a while, then Gran smiled at the teacher, flicked her fingers and went away. The class worked very quietly for the rest of that day and finished all their work.

At the morning play time, Jeremiah was almost sure he saw his Grandma sitting up a tree in the park across the road from the school. At lunch

time he was sure he saw Gran in one tree and Grandad in another. They had rigged up a pulley like the one in The Lighthouse Keepers Lunch and they were passing things in a basket to each other. Jeremiah pretended not to see them. At home time, Gran and Grandad were waiting for them with the bike and sidecar. Jeremiah said,

'Did you two have a nice day?'

'Wonderful!' they both said. 'We went out for a picnic.'

Jeremiah decided not to ask them anything else especially as Anna was crying quietly because she did not have her new pencil case.

When they got home, Gran said,

'I know what's the matter with you, Anna. There are three girls in your school who take everything they want from the other children.'

'How do you know?' sobbed Anna.

'I just know!' said Grandma. 'I'm magic!'

Jeremiah did not say a word although he knew how she knew.

'What can I do?' asked Anna.

'On my last trip, I bought some things which help to stop those girls,' said Grandma. 'Jeremiah will help me make up something for you. You go out to play and don't worry about it.'

So Grandma and Jeremiah went off in to the kitchen, closed the door and stayed in there all evening. Just when Anna was going to bed, they went into her room carrying an old sandwich box very carefully and sat on her bed. Jeremiah took the lid off and showed Anna the strange yellow stuff inside. It looked a bit like glitter, but it did not sparkle.

'When those girls come near you, drop some of that on the ground in front of you and you will have no trouble with them,' said Grandma.

The next day, Anna took the box to school and remembered to take it with her when she went out to play. She took her skipping ropes and her sweets as well. Jeremiah came over to see her.

'How many sweets have you left in the packet?' he asked.

She counted carefully, '1,2,3,4,5,6,7,8,' she said.

Jeremiah said he had 5 sweets left and he was going to keep them until after lunch. Suddenly, Anna saw the three girls coming towards her and she scattered the magic yellow stuff on to the ground in front of her.

'Give me your sweets and those skipping ropes!' demanded the one who had pulled the clips out of her hair.

'Yes, I want a game of skipping ropes with my friends,' said the one who had taken her pencil case.

'Just give me the sweets,' shouted the greedy one who had stolen Anna's lunch and eaten it.

'Take them,' said Anna smiling at them as she held the skipping rope and sweets towards them.

The girls reached out to grab them from her hands, stood on the yellow stuff and stiffened like statues. No one could move them no matter how much they pulled and pushed them. The bell rang for the end of play time. The teachers came out and tried to bring them in.

'Perhaps we should leave them here and phone for their parents,' suggested Anna's teacher. 'There must be some reason why they cannot move.'

'I think they will be free in a minute or two,' Jeremiah whispered to her. She knew Grandma very well and did not ask any questions. The girls suddenly fell over and were free, but they never went near Anna again.

Primary 6.

Name:

The Day Out.

Jeremiah and Anna had been back at school for a few weeks after the summer holidays. The weather was still warm and they wished they could go out to play every day. Mum and Dad did not like them going out after school at night because they lived in a high flat and they could not be seen from the windows. On Friday night, Grandma and Grandad, who lived in the same block of flats, told them to go to bed early and they would all go out for the day on Saturday.

'All of us?' asked Anna. 'In the train or on the bus?'

'No,' said Mum. 'Your Dad and I are going to stay and paint the kitchen and the four of you can go on the motor bike and side car.'

The next day, they set off early and roared along the road before most people were up. The children sat in the side car and Grandma and Grandad took it in turns to ride the bike or be the pillion passenger. They would not tell the children where they were going, but Anna and Jeremiah hoped that it would be the seaside, even though they knew that Grandma and Grandad did not like eating sandy sandwiches because they said it made their teeth blunt.

They rattled and rolled along roads for hours, frequently stopping to eat or stretch their legs. It seemed that every time they turned a bend, the mountains got higher and the bike went slower on the steep roads. Eventually they came to a very high mountain which Grandad said was the highest in Scotland and was called Ben Nevis. Grandma and Grandad had arranged to meet people in the car park at the foot of the mountain.

'At last!' said the lady, 'We thought you would never bring the grandchildren out for a walk.'

'Do you remember Mr. and Mrs. MacSpitfire?' said Grandma to the children. 'We have known them for many years and we often meet up.'

Suddenly Jeremiah remembered that he had met them in Grandma's flat in Glasgow. They had come for a New Year's Eve party and stayed for about a fortnight.

They walked up a little bit of Ben Nevis and saw for miles around. Then they went down to the nearest town which was called Fort William and walked down to the loch side. It really was like the seaside and there were many children playing together in the warm sun while the grown ups sat and chatted. Grandma and Grandad seemed to know people everywhere they went.

'I love it here,' said Anna. 'I wish we could stay.'

'We can,' said Grandad. 'Mr. and Mrs. MacSpitfire said we could all go to their house and stay for the night. We must buy something for us all to eat. Do you have any money with you?'

Primary 6.

Name:

Jeremiah had 43p and Anna had 76p which was 38p less than Grandad had in his pockets. Grandma took the lot and went in to the pizza shop to buy a pizza to take to the MacSpitfires. She had just turned in to the shop door when she realised that the three boys in the shop were not buying pizza - they were demanding money from the man who was serving.

'Stop there!' she roared.

'Just try to stop me....' one of them said angrily.

'I will!' shouted Grandma as she flicked her fingers at them.

'Call the police,' she ordered the man in the shop as the three thieves tumbled and somersaulted through the air and tried to escape. All the people passing by came to look in the shop at their antics. The police came very quickly to their favourite shop and took the thieves away.

Grandma was given four pizzas as a reward and a letter to say that she could have a free pizza every time she visited Fort William. All the people who had come to watch the antics of the thieves felt so hungry when they smelled the pizzas that the shop was soon packed with customers.

On Monday, when Jeremiah's teacher asked if anyone had done anything interesting at the weekend, all Jeremiah said was,

'I went for a run with my grandparents.'

No one would ever believe what had really happened, except maybe the teacher who knew Grandma very well.

The MacSpitfire Visit.

Anna was very excited because it was almost Christmas and she was looking forward to Santa Clause coming. She hoped he would bring her at least some of the presents she wanted. She had written a very polite letter to Santa Clause asking for some presents, but Mum said that Santa did not have much money this year and Anna had not to be disappointed if he did not give her everything she asked for.

Jeremiah was very excited because this Christmas the MacSpitfires were coming down from Fort William to visit Grandma and Grandad. The last time they had come to visit, they had liked it so much in Glasgow that they stayed for two weeks instead of two days. This time they said they were going to stay for two weeks, so Jeremiah wondered when they would leave.

The day the school closed for the holiday, Jeremiah and Grandad went in to town on the bus to Queen Street station to meet the MacSpitfires and to bring them to their flat in a taxi. They were very tired, but they put some interesting looking presents under the tree in Jeremiah's flat before they went up to bed in his Grandparent's flat.

The next day, Grandad said that everyone in his flat was going into town to buy a few presents. Jeremiah and Anna helped their Mum with last minute shopping at the supermarket and Dad went to work. In the evening, after dinner, they all went into town to see the lights. They walked round George Square looking at all the decorations and Christmas lights which looked like bells ringing. Anna was fascinated and stood watching them blinking on and off.

'I thought they would have been more colourful,' muttered Mr. MacSpitfire. 'They're really only the same colour as ordinary light bulbs. Look at all the children here. It would be wonderful if the lights were even more sparkly.'

Mrs. MacSpitfire and Grandma looked at each other, then they spoke to Jeremiah and Anna's Mum before they moved around the square talking to a few other people. Then Mrs. MacSpitfire, Grandma, Mum and the other people all stood together quietly in the middle of the square with their backs to each other in a circle looking up at the lights. Jeremiah wondered what they were doing, but Anna stood holding her Grandad's hand watching all around. Suddenly the lights started changing colours from white to pink, blue, purple, red green, yellow, orange and then the colours changed from being bright to dull to sparkling to glittery. Everyone was amazed as the colours started to change again as though they were drifting from one shade to another like paints being mixed. Suddenly everything went dull for a few seconds, then the lights started changing colours and sparkling, but this time there was the sound of bells playing Christmas songs. Some people joined in singing the words and the noise of the bells became louder until the square was packed and everyone was singing and laughing. Everyone was so happy that very few noticed that the light had gone back to their normal colour.

Mum, Gran and Mrs. MacSpitfire came back to where Anna, Jeremiah, Grandad and Mr. MacSpitfire were standing.

'That was wonderful,' said Jeremiah. 'Was it difficult?'

'The colours were easy,' explained Mum, 'but it was difficult when we knew we had to give the bells 658 lights and 372 glittering streamers.'

'How many lights were changing colours?' asked Anna.

'There were 372 glittering streamers and 964 sparkling lights up there,' said Mrs MacSpitfire proudly.

They were all pleased that everyone was so happy, but it was long past Anna's bedtime, so they had to hurry and catch the bus. Grandad and Mr. MacSpitfire were sitting together on the bus and Jeremiah was in front of them. He heard Mr. MacSpitfire say,

'That was a magnificent display! They could never have managed it without Bella. Everyone knows that no one is as good at magic as Bella MacSpitfire. She's talked about all over the country.'

'Is she?' said Grandad. 'I thought she was famous for knitting scarves that were so long the people who wore them were always tripping up.'

'My Bella is the best knitter for miles around,' snapped Mr. MacSpitfire.

'That's because you live away out in the country miles away from everyone,' replied Grandad.

'No body can knit a hat like Bella,' shouted Mr MacSpitfire.

People on the bus were beginning to look at them, but Grandma, Mum and Mrs. MacSpitfire could not talk for laughing.

'You're right,' said Grandad. 'No one can knit a hat like Bella and I've never seen a head like her hats. Bella's hats are the best foot warmers I've ever had.'

Jeremiah and Anna were glad that they had come to their stop and it was time to get off, but Grandma, Mum and Mrs. MacSpitfire were laughing so much they nearly fell off. Mrs MacSpitfire saw that the children looked worried. She said, 'Don't worry about those two. They started nursery together, were in the same class at school and have been friends all their lives, but both of them think they are married to the witch with greater powers than all the other witches in the world. Every time they meet, they start this argument until we stop them'

'What do you do?' asked Jeremiah.

'Watch!' Mum, Grandma and Mrs. MacSpitfire said.

'We'll have a competition to settle this once and for all,' said Grandma when they came off the lift at Jeremiah's flat and waited for Dad to find his key. 'but I really want a cup of tea.'

Grandad and Mr MacSpitfire sat across from each other on either side of the fire with the children sitting on the rug waiting to see what would happen.

'Just wait until Bella has finished her tea,' said Mr. MacSpitfire. 'She'll show you how good she is at magic!'

'Oh, be quiet, Hamish! You should know by now we never compete,' said Bella as reindeer horns suddenly appeared on her husbands head.

'Take a look in the mirror, Hamish,' said Grandad laughing until his nose grow into a big round red ball.

Mr. MacSpitfire shrunk to the size of a kitten on the chair.

Grandad grew big feet and his shoes popped off.

Mr. MacSpitfire turned bright orange.

Grandad jumped up and started dancing wildly round the room.

Mr. MacSpitfire whistled like a bird instead of talking and feathers sprouted all over his face and hands. His arms started to flap up and down and he looked as though he was going to start flying.

'Don't let them break anything,' shouted Dad.

The lights went out for a second and when they came back on Grandad and Mr. MacSpitfire were back to normal.

'They're both good,' said Mr. MacSpitfire and Grandad together.

The rest of the holiday was very happy. Santa Clause brought Anna everything she wanted. Mrs. MacSpitfire showed Jeremiah how to make noses bright red and other magic tricks.

Arithmetic question.

It was almost Christmas and the lights were on in the square. They looked like white reindeers or bells ringing. Mum, Mrs. MacSpitfire, Grandma and some of their friends gave the bells 658 lights and 372 glittering tinsel streamers to make the show more colourful. Afterwards Mrs. MacSpitfire told Anna that there were 964 sparkling lights. How many lights were there when they went into the square?

The Holiday.

Jeremiah and Anna were very excited because it was the long weekend holiday from school and their Gran and Grandad had promised to take them to visit Grandma's sister in Edinburgh. They had not gone anywhere all summer because their Mum and Dad did not have much money. Their Dad had lost his job when the garage where he had worked closed down and he had been unemployed for several weeks.

Usually Gran and Grandad travelled everywhere on their motor bike and put the children in a side car, but parking was difficult in Edinburgh outside Great Aunt Aggie's house, so they were going on the train. As soon as they came home from school on Wednesday afternoon, they changed, had their dinner and got on the bus which took them into the train station. They got on the Edinburgh train and were there in less than an hour. Grandma's sister lived in the centre of town and was waiting for them at the station. They all took a taxi down to her flat because they had cases with them and it was almost Anna's bedtime.

Early the next morning they were wakened by very loud tuneless whistling coming from the kitchen. Grandad had warned them that Auntie Aggie was not a very good cook and she knew it. He told them to listen to the whistling. She whistled when she cooked. When she was doing something easy like putting bread in the toaster, the whistling was fairly quiet and cheerful, but as she started to burn things or could not follow the recipes, her whistling became very loud and tuneless. That morning she was so noisy, the local dogs were barking and howling and the birds were scared into silence.

Jeremiah and Anna went into the kitchen and heard Grandad say, 'I'm quite happy with a bit of toast. You shouldn't have bothered the soup and black pudding.'

They both tried to creep away before she saw them, but the floor creaked and she shrieked,

'Breakfast's ready! You must eat plenty if you are going to be going around Edinburgh all day.'

Just then Grandma came in and said,

'Their Mum is very strict with them. They must have cereal and milk every morning and a little bit of toast and that's all. I brought a packet of their favourite cereal with me. If I don't obey her rules, she may not let me take them on another trip.'

Jeremiah and Anna smiled and gobbled up their breakfast while Auntie Aggie had a big plate of soup with little bits of black pudding floating in it and Grandad and Grandma had some toast. There was some toast left, so Auntie Aggie dipped it in her tea and finished it off, then she put her hand in the sugar bowl, stirred the sugar around, found her false teeth and put them in. She was sure that the white sugar kept them white and she liked the taste of sugary teeth, so she put them in every night before she went to bed.

'That was lovely,' she said. 'I'm ready for anything now. Would you like to go to the castle?'

They all set off on the long walk from Aunt Aggie's house to the castle carrying the picnic lunch Grandma had prepared. They saw where Kings and Queens had lived a long time ago. When it was time to go home, Grandad said,

'Let's go in to Macdonald's. It'll be my treat.'

'Such a waste of money!' said Aunt Aggie. 'I was going to cook some scrambled egg with beans and cabbage.'

'I insist on Macdonald's!' said Grandad.

The next day Aunt Aggie took them a tour around Edinburgh. When it was time to go home, Grandma said that they would have a take away meal to give Aunt Aggie a rest from her cooking.

'You people from Glasgow must be very rich!' she said. 'I thought we would have jellied eels with some mashed potatoes, I could open a tin of tomatoes to put a bit colour on the plate.'

'It's the children's special holiday,' said Grandma. 'I like Indian food. What about you?' They all had an Indian take away meal that night.

Early the next morning, Jeremiah wakened up to the most awful noise in the kitchen. He rushed out of the room into the hall and Grandad stopped him before he ran into the kitchen.

'I forgot to tell you about this,' he said.

'What's making that noise?' asked Jeremiah.

'You had better go and look for yourself,' said Grandad. 'Don't be afraid!'

Jeremiah went slowly in to the kitchen. Aunt Aggie was marching up and down like one of the soldiers at the castle wearing a long purple kilt and a big orange jumper and playing the bagpipes. She sat down on a chair when she saw him and sighed loudly. She had no breath left for talking. Grandma was standing at the cooker, stirring a pot. The smell was terrible. She turned round to speak to Aunt Aggie.

'I told you not to try anything fancy for us,' she said. 'There was no need to cook mince with prawns for our breakfast, even if it is Sunday. Don't worry about it. That dog upstairs deserves a special treat now that he has stopped howling. Jeremiah, hurry up and get dressed and run up to the neighbours with this mince before Aunt Aggie changes her mind.'

Jeremiah dashed back into the room put his clothes on, and rushed out. He ran right into an old man wearing a long kilt and carrying bagpipes under his arm.

'Oh no!' Jeremiah thought. 'He's going to start! Now we are going to have two of them playing in the kitchen.'

The man looked at him and said,

'Do you have anything to do with that old woman in the kitchen - the one torturing the bagpipes and making a stink bomb?'

'She's my Great Aunt Aggie, my Grandma's sister,' said Jeremiah.

'Be a good boy and tell her to stop cooking. The smell is awful, enough to make a ghost sick. And make her stop playing those bagpipes. We want a bit peace in this house.'

'Do you live upstairs?' asked Jeremiah.

'No, I live here. Aggie has lived here for 89 years,' said the old man. 'She has lived here 243 years less than I have lived here. If you can tell me how long I've lived here, I'll introduce you to my friends.'

Just then Grandma came in with the mince. She said, 'Hello Johnny. You're looking well. What have you been doing since the last time I was in Edinburgh?'

'Not much. I've been round all the old haunts. Can you tell your sister to be quiet?'

'You won't hear those bagpipes again,' said Grandma. 'And I think I know how to stop the whistling.'

Jeremiah and the old man went in to the kitchen. Aunt Aggie was playing the bagpipes but the noise was no louder than a mouse squeak. That afternoon they went out and bought her a microwave and took her to the supermarket to buy lots of ready made meals that she just had to put in the microwave and warm up.

'Thank you,' said Aunt Aggie. 'With all this free time I'll be able to do something I've always wanted to do!'

'What is that?' asked Anna.

'Learn to play the trumpet,' said Aunt Aggie. 'You'll hear me next time you come.'

Arithmetic question.

Aunt Aggie was a very old lady and had lived in the same house for all of her 89 years. She has lived in the house 243 years less than the old man. Grandma used to live in the house, but she moved out when she was 18 to go and live in Glasgow. How long has the old man lived in the house?

The Surprise.

Jeremiah wakened up in the middle of the night. The phone was ringing. It sounded very loud. He slipped out of bed and went towards the open sitting room door to find out what was happening, but his Dad saw him coming and quickly sent him back to bed. The next morning, Jeremiah was so sleepy and Mum and Dad were in such a rush, he forgot to ask about the phone call. That night, after Anna had gone to bed, Mum said,

'Have you ever heard Grandma talking about her twin brother, Oswald, who went to Australia many years ago? He is always writing to her or phoning, but he has never come back home.'

Jeremiah nodded.

'Well,' Mum continued, 'he phoned us last night to say that he was at the airport in Australia and he was coming as a surprise to visit Grandma. He'll take a week or two to reach here as he is stopping off some places on the way home. Don't tell Grandma - he wants to surprise her. Grandad knows, but you must not mention it to Anna because she forgets to keep secrets.' Grandma had told Jeremiah and Anna stories about all her brothers and sisters when they were children and Jeremiah knew that Uncle Oswald, Mr. Macspitfire and Grandad had all been friends at school. They had been in the same class as Grandma and her cousin, Bella. Jeremiah wondered what Uncle Oswald was like. He had seen a programme on television about a man who wrestled with crocodiles in Australia and wondered if Uncle Oswald had caught many. He hoped Uncle Oswald had a surf board.

Jeremiah went home from school every day and whispered to Grandad,

'Is he here yet?'

Grandad always shook his head until one day Jeremiah said,

'Do you think he will ever come?'

'He'll come!' said Grandad.

After a couple of weeks, Jeremiah forgot about Uncle Oswald, so he was very surprised to be wakened early one Saturday morning with banging at the door. A loud voice boomed,

'Open up! I've arrived! It's me! Oswald.'

Uncle Oswald had arrived. He was the tallest and the hairiest man Jeremiah had ever seen. He had a long, thick bright red beard, hair pulled back into a pony tail tied with a leather lace, a curly sheepskin coat, an enormous leather rucksack on his back and a huge case in each hand. Anna peeped out from behind Jeremiah, but Uncle Oswald soon saw her and said,

'Anna! You're just like your Grandma! And this must be Jeremiah. You look like me when I was your age. Hello, Rosie. You look a bit different from

the last time I saw you, but you were only about a fortnight old. And you must be John. Pleased to meet you.'

It was early, so Dad made breakfast for them all while Mum told Uncle Oswald all the latest family gossip. Then she phoned her Mum and Dad and asked them to come down to see her for a minute. Jeremiah was sent to open the door and Grandma rushed on in to the flat to find out why she was wanted and Grandad hurried in to see his old friend.

'Uncle Oswald seems to be great fun,' Jeremiah whispered to Grandad.

'He's too much fun when he meets up with your Grandma! And if Bella MacSpitfire comes to see him, the whole of Glasgow will be in an uproar.'

Jeremiah could not wait for the fun to start. He wondered if Mum would be very cross if he phoned Mrs. MacSpitfire and told her about Uncle Oswald. He did not have long to wonder because he heard Uncle Oswald's loud voice saying,

'I phoned Bella and Hamish MacSpitfire when I stopped in London to let them know I was coming. They said they would be down tomorrow to see me.'

The rest of the day was spent catching up with all of Uncle Oswald's news. He had been all over Australia. He had worked as a sheep farmer, mined for opals, caught some crocodiles, been a chef on a train, worked in a bank, gone fishing and had many adventures.

Next morning, the MacSpitfires arrived. Jeremiah wondered what would happen now. Mrs. MacSpitfire looked at Grandad and said,

'Andy, do you remember that time at school you got into trouble when those mice came out of your pocket? The teacher was standing up on her desk screeching at you to get rid of them and they just kept appearing! It was so funny,' she said and everyone started laughing.

'Children don't do things like that now in school,' muttered Grandad.

'They're too busy with their computers and televisions and phoning their friends to know how to have some fun in school. In our day we wouldn't have sat there hour after hour, day in day out working away without a bit of fun.'

Jeremiah and Anna were shocked. 'We'd be sent home in big trouble if we let mice run around the classroom,' said Jeremiah.

'Our teacher liked mice!' four voices chorused. 'And our friends enjoyed it and we never did anyone any harm - no bullying or disobeying the teacher,' explained Uncle Oswald.

Anna, Jeremiah, Mum and Dad listened while Grandma, Grandad, and the MacSpitfires remembered their schooldays.

Primary 6.

'Maisie, do you remember when we made the frogs do gym with us?' Uncle Oswald asked his sister. 'That horrible boy who always pulled your hair wasn't so keen to go near you when the frogs sat on your head.'

They spent the whole afternoon remembering about their schooldays.

The others listened to tales of magic beans which really did make anyone who ate them jump and bounce all over. They tried to imagine what it was like to try to sit on school chairs that squealed and squeaked then ran away when children went near them. Jeremiah's favourite was the box of pencils which could do school work. Anna wished she had been there when the playground turned all soft and bouncy.

'How did you manage all those tricks?' Jeremiah asked.

'We were learning magic at the same time, so we did some tricks every day. The most we ever did in one week was when we were leaving Primary school and I did 104 tricks, but your Grandma and Uncle Oswald managed 854. Your Grandma was talking about it last time we met. She said she had done 374 of those tricks. You really need to have a good imagination to do that many,' said Auntie Bella.

'How did you get off with all those tricks? I'd be thrown out of school' said Jeremiah wondering what his teacher would do if he tried some.

'Easy enough,' said Uncle Oswald. 'Aunt Jenny, your Great Grandma's sister, was the head teacher. She was really quite proud of us because she had taught us some of the magic herself.'

Arithmetic question.

When Grandma, Uncle Oswald and Auntie Bella were at school and learning magic, they did some tricks every day. The most they ever did in one week was when they were leaving Primary school and Aunt Bella did 104 tricks, but Grandma and Uncle Oswald managed 854. Grandma said she had done 374 of those tricks and it was easy to do that many if you had a good imagination. How many tricks had Uncle Oswald done?